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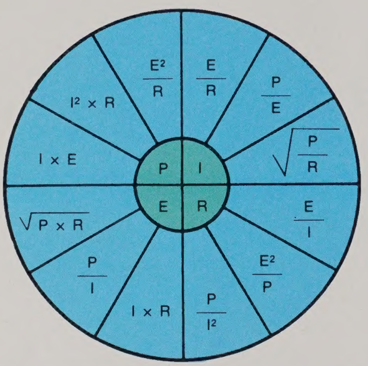

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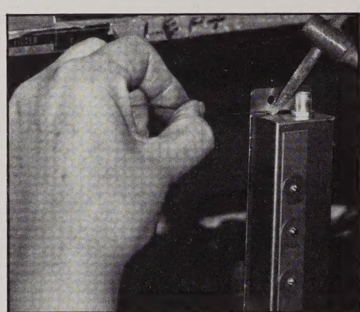

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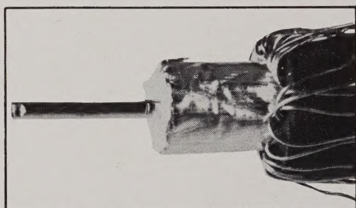

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Installer/Technician is published monthly by Communications Technology Publications Corp., 12200 E. Briarwood Ave., Suite 250, Englewood, Colo. 80112—or—P.O. Box 3208, Englewood, Colo. 80155, (303) 792-0023. June 1988, Volume 1, Number 2. Office of publication is 12200 E. Briarwood Ave., Suite 250, Englewood, Colo. 80112. Change of address notices should be sent promptly; provide old (or copied) mailing label as well as new address, including ZIP code; allow 6 to 8 weeks for change. Third Class postage paid at Denver, Colo.


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From the Publisher

Training is forever

Look around: Who in your company seems to rise through the ranks faster than anyone else? Is it the tech who remains at the same level of knowledge and ability? Or is it the one who attends seminars and perhaps is enrolled in a correspondence course? Well, as you might have guessed, it's the latter. Training is the key to a better future.

To list the many sources of training would fill several pages. However, turn to the "Calendar" section on page 56 for just a few sources: technical training seminars from manufacturers (Hughes Microwave, C-COR, Siecor and others); at regional conventions (New England Show, Great Lakes Expo, etc.); and from regular gatherings of chapters and meeting groups of the Society of Cable Television Engineers.

The SCTE is a veritable gold mine of training opportunities for every technical person in CATV. And it's not in some faraway place: With nearly 45 groups scattered across the country, there's literally one in your neighborhood. Seminars run the gamut of topics from A/B switches to Yagi antennas.

Beginning with next month's issue we will provide a list of each SCTE group along with the name and phone number of a contact person. But in the meantime, if you're interested in joining a local group (and why wouldn't you be?), contact the SCTE national headquarters at (215) 363-6888.

The big event

This month is also the SCTE's big event—Cable-Tec Expo '88, June 16-19 at the San Francisco Hilton. If you're not already familiar with it, the expo is a fully technical conference and trade show offering a variety of educational programs, technical training sessions and hands-on workshops. Even the exhibit floor is a "classroom," featuring various types of industry hardware.

Each attendee will be able to select six of the 10 expo workshops to sit in on. All workshops will be held in the morning. Topics include rebuilds and upgrades, signal leakage and CLI testing, FCC compliance, BTSC stereo, spectrum analysis, and developing a technical training program. Review course workshops will be held for BCT/E Certification Program Categories III, V and VI.

A major project will be unveiled in one workshop at this year's expo—the SCTE's new Installer Certification Program. The workshop will provide an overview and review course on the new certification and will detail the Society's methods of determining certification through exams and practical demonstrations by the candidates. The SCTE also will establish an installer's level of SCTE membership.

If you're not planning to attend, we'll provide a synopsis of the expo in an upcoming issue (and hope to see you in '89). And if you're reading this in Frisco, welcome to the best technical convention in the industry. Take this opportunity to "soak up" all the knowledge you can.

Pat on the back

This is only the second issue of *IT* and already we're receiving letters of appreciation from our readers. Thanks for the kind words—just keep them coming. But also tell us what you like, dislike or want to see more on. And if you have any ideas for articles or just would like to drop a postcard with one of your tried-and-true "tech tips," let us know. We're here to serve you.

Next issue we'll be starting a new department, "Out of Focus"—and you can participate. Just send in a slide or photo (color or black and white) featuring some humorous, offbeat or unusual situation that occurs in your daily routine on the job. If we choose your entry, you'll appear in *IT* and receive $25. Send your entries to: Out of Focus, CT Publications, P.O. Box 3208, Englewood, Colo. 80155.

Finally, I'd like to introduce Stan Wiecinski to our advisory board. Stan is vice president of operations for the Installation Division of NaCom Corp. Welcome aboard.

Paul R. Levine

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See us at the Cable-Tec Expo, Booth 602. Reader Service Number 5.

Educational materials available from SCTE

EXTON, Pa.—The Society of Cable Television Engineers is featuring a catalog of SCTE materials in the June issue of its monthly newsletter, *The Interval*. This catalog, which will be available at the Cable-Tec Expo June 16-19 at the San Francisco Hilton, includes information on the SCTE's educational publications, audio transcripts, videotapes and new products. Some of the items offered and described include:

- *Cost-Effective Designs for Rural CATV Systems* by William Grant (book)—"An informative approach to rural cable television system design and operation based upon the tapped trunk theory (single-cable distribution). Includes design specifications for four, eight and 12 taps per mile with up to 17 miles of cable and 45 amplifiers in cascade. Also provides guidelines to develop an effective cost estimate for rural cable builds."
- *Practical Design of DC Power Supplies* by Joseph Carr (book)—"Technical theory and data on DC power supplies for the technician and engineer. Includes basic information on the elements of a DC power supply, including transformers, rectifiers, voltage multipliers, filters, voltage regulators, overvoltage protection and current limiters. Also includes several specific DC power supplies."
- *CATV Signal Level Meters: Errors and Accuracy* (videotape)—"Graphics and discussion cover linearity, calibration, measurement range and increments, resolving power capabilities, attenuator steps and peak detector error. On-camera demonstration shows proper use of meter scale. Program covers gain changes, temperature and calibration, shape factors and IF bandwidth."
- *Developing a Preventive Maintenance Program* (videotape)—"Ron Hranac of Jones Intercable discusses one of the most important aspects of subscriber satisfaction: system preventive maintenance. Recommended practices for the reporting and correction of system problems are addressed in this seminar, which also includes maintenance procedures for correcting potential problems before they occur."
- *Implementing Stereo Headend Equipment* (videotape)—"Audio Engineers Tom Williams and Steve Fox discuss BTSC stereo technology and its proper testing through specific headend equipment in this workshop from Cable-Tec Expo '87."

In addition, audio transcripts cover such topics as signal leakage, test equipment, system sweep techniques, and upgrades and rebuilds. Promotional items include T-shirts, mugs, binders, plaques and tie tacks.

Jones Intercable begins new installer program

ENGLEWOOD, Colo.—Jones Intercable is implementing its new Qualified Installer Program (QIP), designed to offer a long-term approach to performance management through ongoing monitoring.

QIP is based on the Performance Plus Installer Program and has several parts: 1) an illustrated installer's manual, 2) a statement of commitment regarding the priority for quality installations and customer service, 3) a written self-evaluation of the manual's practices and policies, 4) a written proctored evaluation when the installer is ready, 5) initial and recurring field evaluations and 6) a formal method to include the QIP results in the personal record.

Reaction to QIP in the test systems has been positive. Participants provided input as to what elements in the program needed revision, such as the need for a waiver policy of specific practices and procedures that were unsuitable to a particular system. QIP also was found to improve individual and team morale.

QIP implementation began in late November 1987.

What's new with the SCTE?

This month, the Society of Cable Television Engineers presents an update on recent Society activities and news of interest to all installers and technicians in the cable television industry.

- Cable-Tec Expo '88, to be held June 16-19 at the San Francisco Hilton and Towers, will be the site of the introduction of the Society's new Installer Certification Program. An overview and review course

easy access to a library of calculations used in system operations on a daily basis. Designed to run on IBM personal computers and compatible computer systems, CATV Wizard is currently available by mail order in the June issue of the Society's newsletter *The Interval*, which is a special catalog of the Society's publications, videotapes and other products.

- The SCTE board of directors elected its new officers for the coming year at a meeting held April 30 prior to the NCTA show in Los Angeles. The officers are as follows: president—Ron Hranac, Region 1 director, Jones Intercable; Eastern vice president—Bill Kohrt, Region 6 director, General Instrument/CommScope; Western vice president—Richard Covell, at-large director, General Instrument/Jerrold; secretary—Wendell Woody, Region 5 director, Catel; and treasurer—Gary Selwitz, Region 11 director, Warner Cable Communications.

The April 30 meeting represented the first gathering of the board of directors since a national election was held for eight board seats in early 1988. Over 1,110 ballots were received from SCTE members during the election. The current SCTE board of directors consists of: at-

Wendell Woody, Catel, serving Illinois, Iowa, Kansas, Missouri and Nebraska; Region 6—Bill Kohrt, General Instrument/CommScope, serving Minnesota, North Dakota, South Dakota and Wisconsin; Region 7—David Spallinger, Continental Cablevision, serving Indiana, Michigan and Ohio; Region 8—Jack Trower, WEHCO Video Inc., serving Alabama, Arkansas, Louisiana, Mississippi and Ten-

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- *Developing a Preventive Maintenance*

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- SCTE is releasing CATV Wizard, a new computer software product, at Cable-Tec Expo '88. This is a computer disk containing 30 computer programs that run mathematical formulas used in CATV technical calculations. It was developed by the Society to provide well-tested and thoroughly researched formulas to the industry at a low cost. With this product, the industry's technical personnel will have easy access to a library of calculations used in system operations on a daily basis. Designed to run on IBM personal computers and compatible computer systems, CATV Wizard is currently available by mail order in the June issue of the Society's newsletter *The Interval*, which is a special catalog of the Society's publications, videotapes and other products.
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Maintaining a headend

By Richard Olson
Headend Engineer, United Cable Television

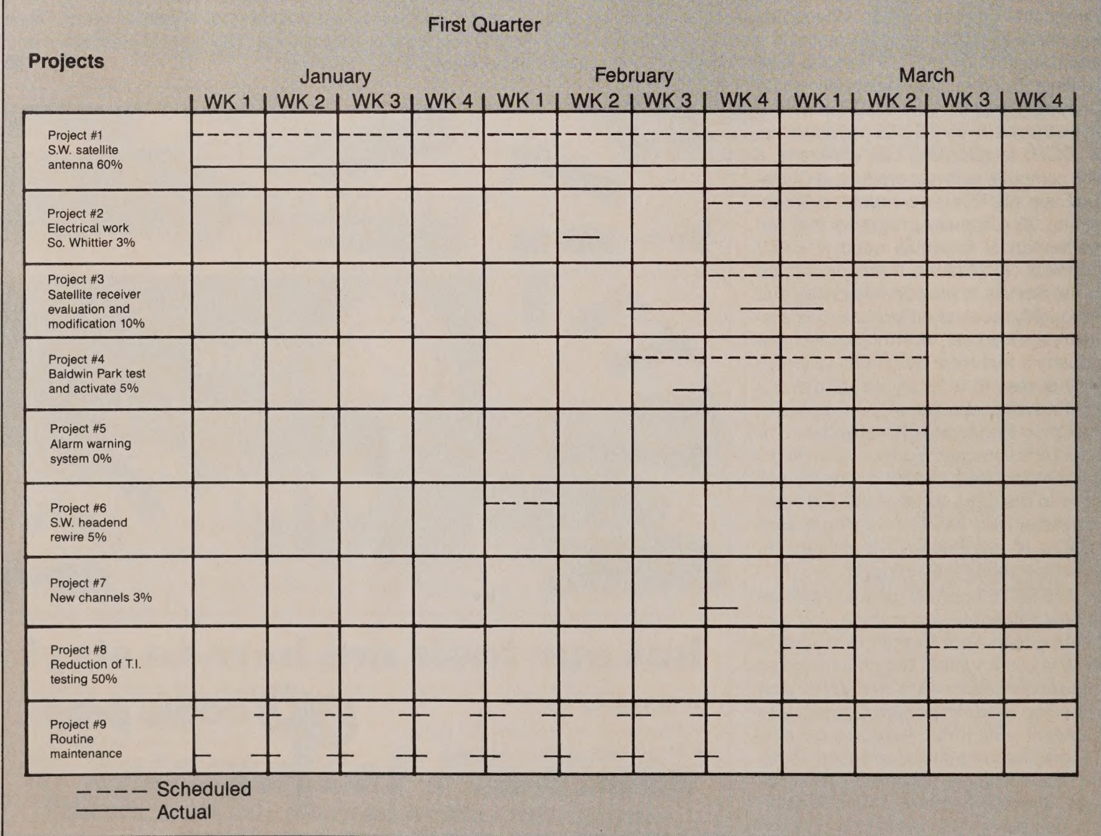
Anyone who has been involved with a headend is well aware that there always seems to be too much to do and too little time to do it. You find yourself correcting problem after problem and not making the progress you desire. If this doesn't sound familiar, you are one of the lucky few. I have found that the following three steps will generally help a new headend or a line maintenance technician successfully troubleshoot and maintain a headend.

Organization

Organization will allow you to complete projects that have been pushed back or simply put off. Organization consists of establishing projects, scheduling and tracking. Your supervisor will be of great help to you in establishing projects. Some standard projects include peaking the off-air satellite antennas, checking the cabling and connectors, setting the RF input levels to the processor and/or demodulators to the manufacturers' specified levels, adjusting the baseband video and audio outputs to all of the corresponding equipment, setting the AGC voltage of the VideoCipher II units, setting the video and audio carrier levels at the combined test point, adjusting video modulation and audio deviation and so on.

Now that you have an idea of what needs to be done, you must determine how much time each project will require. Since every system is different, you will have to rely on your own experience

Scheduling and tracking chart



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SCTE member cost - $35.00
Cost from publisher - $39.00

Cable Communications by Thomas F. Baldwin and D. Stevens McVoy
An insightful look at the CATV industry, encompassing its technology, services, organization, operations, and future. Features special appendices on cable regulations, networks, policies, costs and audience survey methods. Second edition.

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to determine the number of hours for each project. For example, peaking a single yagi VHF antenna on a 100-foot tower will probably take two people a half to a full day (eight to 16 hours), depending on the condition of the cabling and connectors. Estimate the hours required for each project and note this next to the corresponding project on your list.

Next you need a method to schedule and track these projects. This should be done on a chart that allows you to visualize all of your projects and how they relate to one another, design it into any time frame you desire and monitor both the proposed schedule and the actual progress. Allow for suppliers' lead time for any material or equipment orders.

Possibly the most important thing to keep in mind as you build your chart is to make the chart fit the projects, not the projects fit the chart. The chart is built around the proposed schedule of all of your projects.

Routine maintenance

The second step is to routinely monitor certain parameters of your system. These parameters should include visual and sound checks of all programming at least daily; adjustment of video and audio carrier levels, video modulation, audio deviation, ingress testing and spurious beat products on a biweekly basis; baseband video and audio levels, intermediate frequency (IF) levels, power supply voltages and incidental AC ripple on a monthly basis; and standby generator and air-conditioning operation on a quarterly basis.

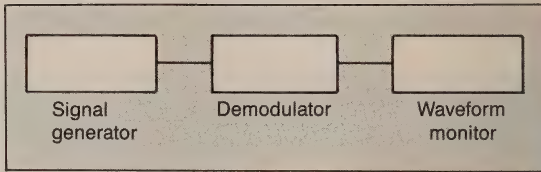
Routine maintenance should be scheduled in your projects list. The biweekly checks take three hours a week, the monthly checks about four hours for a 60-channel system and the quarterly checks take 30 minutes. Our maintenance program cut our standby call-in from an average of four calls per week to one call every five weeks.

Preventive maintenance

The final step is to establish a preventive maintenance (PM) program. This should be included on your project list and scheduling and tracking chart. PM is a method that enables you to identify equipment that does not meet specifications or equipment that exhibits changes in specified characteristics from one test period to another. This will allow you to correct problems that currently exist and prevent many future problems from occurring. The following are PM test setups and procedures:

A) *Differential gain* is a change in the chrominance (color) as the luminance (black and white) changes. Test equipment should include a video signal generator, a calibrated demodulator (frequency agile, if available) and a waveform monitor. Use the following test procedure:

1) Set the video signal generator to 10 riser staircase with color subcarrier on.
2) Check the waveform monitor for proper termination and adjust output of demodulator to 1 volt = 140 IRE units.



3) Set the waveform monitor to 3.58 MHz bandpass.
4) Adjust the waveform monitor to display 100 IRE units of filtered video.

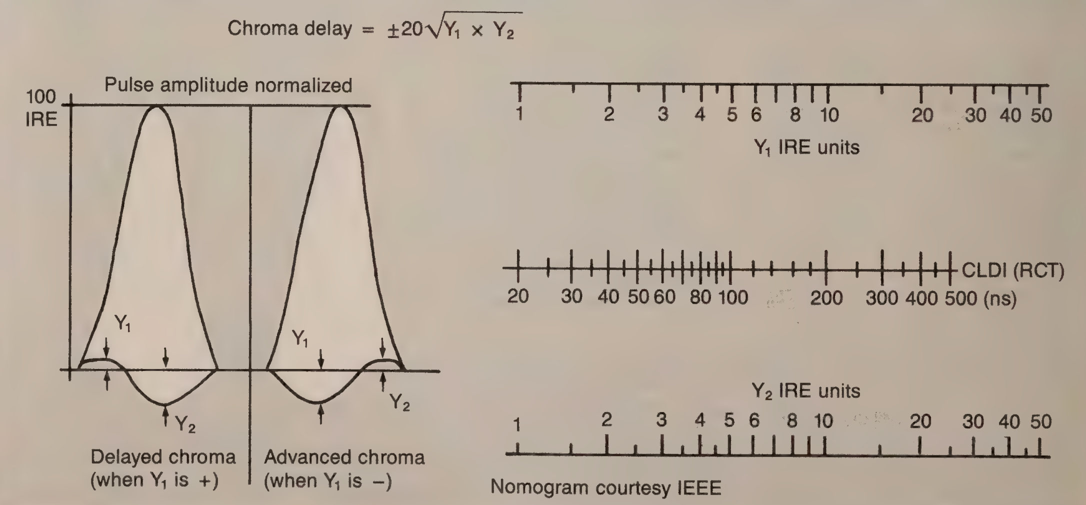
$$\text{Differential gain} = 20 \log_{10} \frac{G1}{G2}$$

G1 = minimum of waveform difference
G2 = maximum of waveform difference

B) *Differential phase* is the variation of the 3.58 MHz color subcarrier with the average picture levels maintained and the luminance varied from blanking to white. Test equipment should include a video signal generator, a calibrated demodulator, a waveform monitor and a vectorscope. Use the following test procedure:

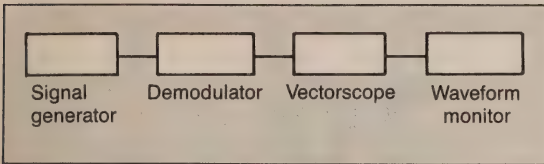
1) Set the video signal generator to 10 riser staircase with the color subcarrier on.
2) Loop the demodulator video output through the vectorscope

Figure 1: Chrominance-luminance delay nomogram with measurement convention



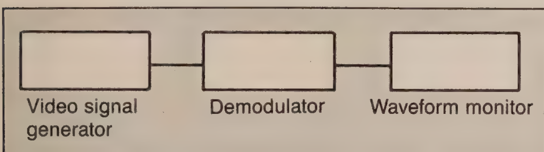
Nomogram courtesy IEEE

and then to the waveform monitor and terminate.
3) Adjust the demodulator to 1 volt = 140 IRE units.
4) Set the vectorscope to:
   a) Channel A; A0 (phase)
   b) full field
   c) differential phase



5) Set the signal doubler switch to double.
6) Turn the phase dial until the two lines on the vectorscope display lineup and read the phase shift from the dial indicators.

C) *Chrominance-to-luminance delay inequality* (funny paper effect) is the difference between the chrominance group delay and the luminance group delay. Test equipment should include a video signal generator, a calibrated demodulator and a waveform monitor. Use the following test procedure:
1) Set the video signal generator to composite.



Monthly headend/hub power supply report

Location: ______________________ Date: ________

Loop: ______________________ Tech: ________

CHECK ONE : ENCODER ______ MODULATOR ______

Channel	Volts DC	Ripple	Channel	Volts DC	Ripple
2			31		
3			32		
4			33		
54			34		
5			35		
6			36		
14			37		
15			38		
16			39		
17			40		
18			41		
19			42		
20			43		
21			44		
22			45		
7			46		
8			47		
9			48		
10			49		
11			50		
12			51		
13			52		
23			53		
24			62		
25			63		
26			64		
27			65		
28			66		
29			67		
30			68		
			69		

Settings for Volt Meter.
VOLTS DC: Volts /200 ; AC/DC set to DC.
RIPPLE: AC/DC set to AC ; Volts / 200 mv.

Comments : ______________________________

Quarterly headend/hub report

Location: ____________________ Date: ____________

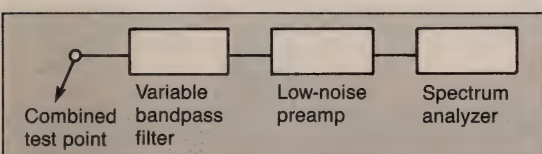
Temp: ____________________ Tech: ____________

STAND-BY GENERATOR	AIR CONDITIONERS
HOURS :	SETTINGS
TEST NO LOAD — CYCLES : ________	HI TEMP : ________
TEST NO LOAD — VOLTAGE : ________	LOW TEMP: ________
OIL LEVEL : ________	O N A N MOST RECENT SERVICE
WATER LEVEL : ________	
BATTERY FLUID LEVEL : ________	DATE: ________
BATTERY CHARGE VOLTAGE : ________	AIR CONDITIONER MOST RECENT SERVICE
BATTERY VOLTAGE : ________	DATE: ________
TRANSFER TEST	EMERGENCY PHONES :
TEST WITH LOAD — CYCLES : ________	O N A N : (213) 426-0311
TEST WITH LOAD — VOLTAGE : ________	AIR CONDITIONER: (818) 579-1800
O N A N COMMENTS OR PROBLEMS	AIR CONDITIONER COMMENTS OR PROBLEMS

2) With the waveform monitor terminated, adjust the demodulator to 1 volt = 140 IRE units.
3) Center the 12.5T pulse on the waveform monitor display.
4) Using the venier and volts switches, adjust the pulse from the zero line to the 100 IRE line.
5) Set magnifier to .5.
6) Reposition the pulse on the screen.
7) Calculate the inequality on Figure 1.

D) *Carrier-to-noise (C/N)* is the ratio between the desired carrier and the RMS (root mean square) noise terminated to 75-ohm impedance within a 4 MHz band. Test equipment should include a variable bandpass filter, a low-noise preamplifier and a spectrum analyzer. Use the following test procedure:

1) Set the spectrum analyzer as follows:
   a) frequency span/div. 1 MHz
   b) resolution bandwidth 300 kHz
   c) time/division = auto or 2 milliseconds
   d) trigger to auto
   e) video filter off
2) Measure the difference between the desired carrier and the noise floor. A 10 dB difference between analyzer noise and system noise is necessary for correct measurement. If you do not have this, you will need to increase the system signal level. This is done with a CW carrier.



Biweekly headend/hub report

Location: ______________________ Date: ______________

Temp: ______________________ Tech: ______________

Chan.	V	A	DF	M	Ing	C/N	C/B	S/N	Chan.	V	A	DF	M	Ing	C/N	C/B	S/N
2									31								
3									32								
4									33								
54									34								
5									35								
6									36								
106.5									37								
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Settings for Spectrum Analizer :

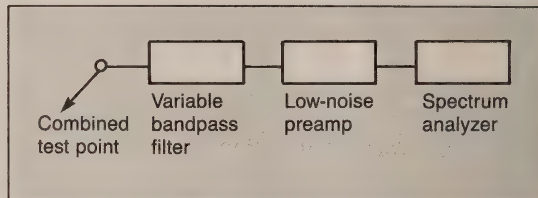
VIDEO: 1 dB per div ; 500 KHZ freq. span ; 3 MHZ Res/BW.
AUDIO: Remove 10 dB attenuation ; 200 KHZ freq. span ; 300 KHZ Res/BW.
MODULATION: Linear 0 KHZ freq. span ; 300 KHZ Res/BW ; Adjust at 87.5 %.

Comments : ______________________________

3) Correction factor of 18 dB must be added to compensate for the difference between the 300 kHz resolution bandwidth of the analyzer and the 4 MHz bandwidth of a television signal C/N ratio = 13 dB.

E) *Carrier-to-beat ratio* is the difference between the desired carrier and any interfering carrier (beats) within the channel's band. Test equipment should include a variable bandpass filter, a low-noise preamplifier and a spectrum analyzer. Use the following test procedure:

1) Tune the bandpass filter and the analyzer to the desired carrier.
2) Remove the modulation from the carrier and peak on the analyzer display.
3) Remove the carrier and measure from the reference to any undesired "beats" in the band. This will be expressed in dB and will give you the ratio of undesired to desired signal.



4) Set the spectrum analyzer as follows:
   a) 1 MHz/div.
   b) 100 kHz resolution bandwidth
   c) time/div. "auto"
   d) trigger "auto"

Character generators and ad insertion equipment

By Jay Vaughan
Project Engineer, Engineering and Technology
American Television and Communications Corp.

The installation and maintenance of character generators and local advertising insertion equipment is usually left to a video technician or headend technician. Nevertheless, it is important for the installer and the field technician to understand the basic operation and possible effects of the equipment—particularly, problems that subscribers might see as a result of improper maintenance or failure of the equipment.

Character generators

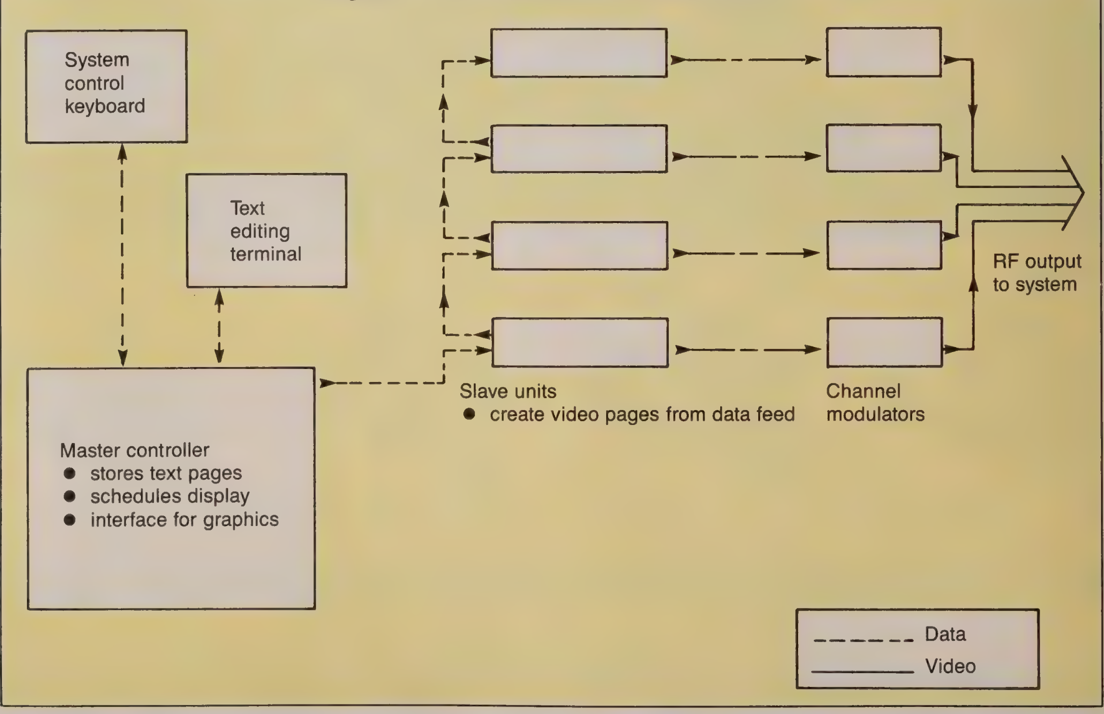
The first character generators (CGs) were able to store only one or two pages of information, and the text was displayed in a single type font (character style or size) with a limited choice of background colors. They were originally used by cable operators for "filler" materials on extra channels that were available. Today, CGs are available with a range of characteristics. Newer models have many font choices and can display several background colors at the same time.

CGs also can store hundreds of text pages and can interface with graphics equipment for display of figures and other images along with text information. Specially configured units can accommodate some of the newer programming services. Modified CGs can display data received either by satellite or telephone data lines. Data services provided in this way include listings of channel programming, weather information, stock quotes and news wire services. CGs can be set up as single stand-alone units that output a single page of text at a time. Or, by using a master control computer, they can be linked to operate as a system. In this way, each CG acts as a "slave unit" and provides specific pages of text to a particular channel. Generally, the master control unit stores pages of text that have been created then sends the information to a CG slave unit for display on a predetermined channel based upon a given schedule (Figure 1).

On the one hand, CGs can produce very bright, vivid pages of text and graphics displays that look good even at the perimeters of a cable TV system where other pictures are beginning to look noisy. On the other, they can create problems for TV sets, new models as well as older ones, that are not properly aligned.

The most common problem is a buzzing sound on the program audio called "sync buzz." This is caused by the combina-

Figure 1: Character generator system layout



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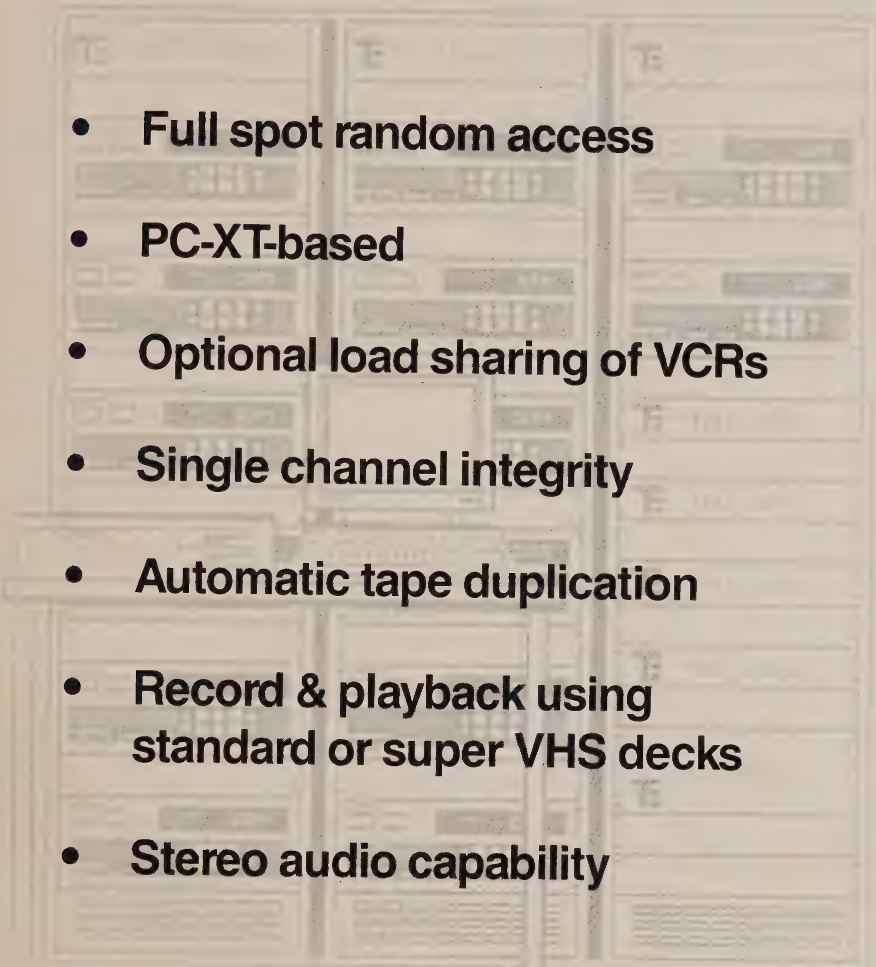

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tion of the crispness or definition of the lettering used on the text page, the color of the characters and the color of the page that the lettering is on. Even with proper CG alignment and modulator setup, sync buzz may be heard on a fair percentage of sets in the system. The brighter the white lettering when inserted on a dark background, the more noticeable the buzz will become.

Fine tuning of the TV set is also critical on a character-generated channel, because even the slightest mistuning can result in the sync buzz. And although a test set connected to the cable in the subscriber's home may not buzz, the installer or technician should verify that the cable system's CG units are set up or operating properly before concluding that the problem is with the TV set. To eliminate the buzz, it may be possible to program the CGs with a more subdued color for the text and background page.

While on the subject of choosing colors for the text and background displays, another point worth mentioning is the effect of the color choice on the amount of noise that one may perceive in the picture. The experienced CG programmer may be able to reduce the amount of noise that is visible in the display pages on a customer's television while also minimizing the chances for sync buzz. Intermittent loss of a converter/descrambler's ability to decode a channel while it displays character-generated information also can be a result of the same criteria that may cause sync buzz; that is, choice of non-ideal coloring of text and background, or improper setup. CGs are basically computer technology devices and as such are sensitive to AC power line outages or glitches. A momentary loss of power may only cause some of the text to appear garbled, while a complete outage lasting a few seconds may cause the unit to lose all stored text pages, resulting in a blank screen, an empty page or a random display of characters. Fortunately, better units normally have a backup battery to prevent loss of information as a result of power outages.

Commercial insertion equipment

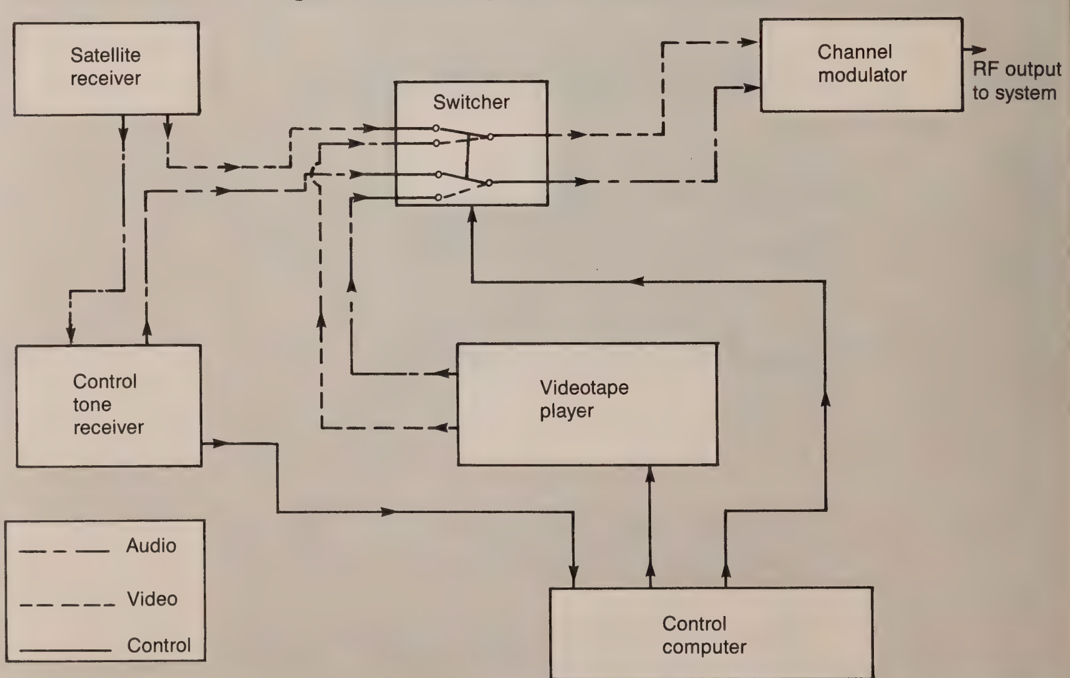
The insertion of local advertising into satellite-delivered services has recently developed as a revenue producing opportunity for cable systems. The number of channels (services) used for local ad insertion varies, ranging from one to eight channels. Four channels are probably the average.

Local ad insertion equipment to accommodate these services has progressed significantly over the last five years. Originally, commercial insertion was achieved by an operator who put a tape in a player and flipped a switch when it was time to run a commercial spot. In contrast (see Figure 2), today's state-of-the-art equipment consists of a computerized system that automatically schedules, plays and logs commercials through control of up to 25 tape players and switchers. Additionally, these units can automatically insert ads into several channels simultaneously.

The fundamental component in any ad insertion system is the videotape player (VTP), used to playback the prerecorded commercial. Depending on the complexity of the insertion system and the number of channels with ad insertion capability, a system has as few as two VTPs or as many as 30.

In fairly simple systems, the VTP is controlled by a simple device that listens for special tones sent by the satellite programmer, indicating that the local systems can insert an ad eight seconds after the first tone. When a tone occurs, the control device sends a command to the VTP to start the tape then swit-

Figure 2: Insertion system layout (single channel)



ches out the video program feed from the satellite receiver and replaces it with the signal from the VTP. When the tone is sent to indicate that the local insertion period has ended, the control device switches the satellite program feed back onto the channel and stops the VTP.

In more complex systems, the controller has a schedule of different commercials to be run on each channel. Before the local ad is scheduled to run, the computer automatically instructs a specific VTP to find a specific advertisement on a tape, which also may have 20 or more other ads on it. The computer now monitors the control device referenced earlier and instructs the VTP to start playing the local ad when the satellite start tones are received. When the first ad is finished, it may have a different machine play another ad on the same channel. Or, it may simply instruct the VTP to get ready for the next scheduled ad. The computer then logs what time a specific commercial played and on which channel. To protect the programming from extended interruptions, the better systems are designed to automatically switch back to the satellite video feed after a preset amount of time (usually 60-120 seconds)—i.e., even without the indicating tone to return to the satellite programming.

Picture quality on channels capable of the insertion of local advertising is usually only affected by the insertion equipment close to and during the time the local spots are being aired. The total amount of time involved usually does not add up to more than two minutes per hour on a given channel. Changes in audio level and a reduction in picture quality while airing the local spot are probably the most common problems associated with the ad insertion process. The change in audio level is in some cases the result of a popular VTP's inability to produce the "standard" audio output level that most satellite receivers are set up for, thereby causing a change when the local spot is played.

The picture quality degradation is usually a function of the number of times the tape containing the ad is copied during the editing process (this process is needed to build a tape containing multiple commercials). Also, the original production of the commercial may have been done with less expensive equipment and therefore lower signal quality than with comparable network advertising. Also, without proper maintenance of the VTPs, the picture quality of the aired commercial may be impaired.

Commercial insertion systems that do not feature video time base correction and/or frame synchronization may cause the picture on television sets to roll once at the beginning or end of a local ad insertion. If the insertion system controller does not have a feature that forces it to switch a channel back to its original video feed after a preset amount of time, the channel could go blank following a local commercial if the control device did not receive the tones that inform it that the local avail is finished.

In these situations, while there is little actual corrective work that installers and field technicians can do, they can provide valuable information to cable operators on problem symptoms and how extensive the problems are.

A valuable link

All of us in the cable industry would like to be able to deliver the highest quality signal possible on all channels. Proper operation and maintenance of character generators and commercial insertion equipment can contribute to this goal and, in turn, to subscriber satisfaction. By being aware and understanding the symptoms of improper settings and fault equipment for headend equipment as well as subscriber equipment, installers and field technicians can be a valuable link between transmitting equipment operators and the subscriber. ■

Headend design considerations

By Patrick K. McDonough
Corporate Chief Engineer, United Cable Television Corp.

Although there is not much call for the construction of new headends anymore, a thorough understanding of what is involved in this process is helpful in both upgrade situations and for ongoing maintenance. This knowledge will allow a technician to quickly and confidently troubleshoot headend problems. Further, in the case of a system rebuild/upgrade, technical personnel can properly engineer headend expansions.

Cable TV headends are unique in many respects. They can be as complicated as a broadcast studio or as simple as a SMATV (satellite master antenna television) setup. In any case, the primary function of a headend is to provide consistent, high-quality television signals to a cable system.

Planning is the key

In any endeavor, proper planning can mean the difference between failure and success. The design and implementation of a cable headend is no different. There are so many things that can go wrong that a thorough plan is necessary to minimize the potential for problems.

The first step in headend design is to determine exactly what the headend will be expected to do. How many channels will ultimately be required, how many of these are satellite fed or off-air, VideoCipher requirements, the number and type of locally originated channels, ad insertion needs, pay-per-view needs, possible BTSC stereo channels, scrambling methods, tiering schemes, emergency alert requirements and the number of trunk lines to be fed are all items to consider before a headend can be designed. Each of these items is necessary so proper rack space can be allowed, enough power and air-conditioning provided and the correct size room or building constructed.

It is very important that the ultimate channel capacity be determined up front and at least a fairly firm lineup be decided upon before the actual headend design is started. Without this information, you could end up with something as small and completely packed as a jet cockpit or the size of a small hangar filled mostly with expensively cooled air.

Once a channel lineup and final capacity have been determined, the next step is to draw up a preliminary racking plan. If you know what types of equipment you will be using, pull the specifications sheets and note the sizes of each piece of gear. Fortunately, there has been a good deal of standardization in size within the industry so this process is fairly easy. Good thing too, because the rack plan is very rarely correct and usually has to be redone a number of times.

My preference is to rack for all potential channels, present and future. Allow sufficient space for scrambling, BTSC encoders, combiners, splitters and other necessary equipment within the racks. It is critical that air flow be considered during this step. If open racks are to be used, allow for a separation of 1¾ inches between each piece of equipment. If closed racks are used, a spacing of 1¾ to 3½ inches should be figured. The use of rack fans should be considered and adequate space included if necessary.

In racking a headend, the method I prefer is to provide for a logical signal flow. For instance, all of the input signals, whether satellite, off-air or local origination, are fed into one end of the rack setup and proceed through to the output at the other end. If this approach is used, it is necessary to plan for rack placement in allowance with the scheme. That is, the input end of the racks should be close to where the antenna leads and earth station feeds actually enter the room. This kind of plan also allows for a grouping of similar pieces of equipment. All of the satellite receivers, demods, character generators, etc., are collocated. If space is allowed for spares, then in the event of a problem the bad piece can be quickly bypassed and the spare connected into the circuit. This also allows a great deal of flexibility if channel changes are made in the future as satellite services change.

Another approach gaining popularity is to cluster channel-specific equipment. This involves locating all of the equipment for each channel together. For example, a cluster for HBO might include the satellite receiver, VideoCipher, BTSC encoder, scrambler and modulator. Interconnecting leads are kept short and, other than power cords, the only external wiring to each cluster is one input cable, one output cable and perhaps a lead to/from the addressable controller.

The type of scrambling used, if any, will affect the rack-up. In systems where baseband scrambling is employed, the signals must be at video. This means that demodulators and modulators may be needed for off-air channels and should be planned for in the rack scheme. Whatever the case, it is good engineering practice to rack the headend for all future channels with feed lines, audio cables and control lines, all permanently in place. By doing so, patch panels and jumpers are all that are needed to accomplish channel or service changes.

Floor plan

When a fairly complete rack diagram has been completed, a floor plan should be devised. In cases where an existing room is being used, arranging the racks may take a bit of ingenuity. In a new facility, adequate floor space can be specified in the beginning. Racks used to be laid out in a straight line. In today's expanded bandwidth systems, this could mean a headend the approximate length of a coal train, so other configurations are the norm. These can be L-, C- or U-shaped designs.

When laying out the floor plan, remember the following factors: signal input and output locations, air flow, entry (door) location and access. As noted before, the input equipment racks should be physically located near the feed line entry. Also consider the flow of air within the room so that no "hot spots" result due to flow restrictions. Allow adequate space in front of and behind the racks so maintenance can be performed quickly and easily. There is almost nothing as frustrating as having a piece of equipment go down and not being able to get to it.

Another important factor to consider in the floor plan is the wiring. Some technicians prefer top of the rack wiring, while others prefer bottom wiring. I prefer using a computer floor and running everything underneath the racks. A computer floor also can be fed with cold air that is then vented into the bottom of each rack. This is the most efficient method of ensuring adequate temperature control short of building the whole headend inside a giant refrigerator.

Thought also must be given to electrical wiring. Again, a com-

puter floor is advantageous in that a dedicated outlet can be positioned at the base of each rack. In cases where this type of flooring cannot be used, installing the plugs at ceiling level is usually the best alternative. This eliminates the accidental disconnection of power to the racks and prevents accidents as well.

Several other items must be considered when doing the floor plan. A work bench with power outlets should be included, as well as a storage area for spare parts and tools. Most of the test equipment should be racked up with the headend, but a good bench test setup is a useful addition in any headend. If an addressable control computer is to be located in or near the headend, include adequate floor space, environmental controls and AC line conditioning in the overall plan as well.

One further notice on wiring: It is very important to identify each wire in the headend, at both ends, with a permanent type of marker. The use of colored cables also is of great benefit as an aid to troubleshooting and maintenance. For instance, all modulator inputs can be done with blue wire, outputs with green, video with red and so on. In wide-bandwidth headends with all the bells and whistles, this can cut problem resolution time significantly. In any case, a schematic diagram of all headend wiring should be part of the overall project.

Powering and air-conditioning

Now that the racking and layout are done, it is time to figure out how much power and air-conditioning will be needed. Whatever the size of your facility, do not use too small a number of power circuits because a single fault can result in the shutdown of a large number of channels or even the entire headend. It may cost a little more up front, but it is better to plan for a larger number of separate power circuits that, at worst, would affect only one or two racks. Power planning is based on the equipment specification sheets. Simply total the wattage required for all the equipment to be fed off each circuit and protect each line with a breaker rated about 1½ times the maximum calculated load.

In some locations, you must consider the use of a power conditioner to smooth out power surges. Take care in selecting a conditioner, since a failure in this unit can be difficult to bypass. A standby power system also must be planned. UPS (uninterruptible power supplies) systems may be used in cases where computers are installed and there is a good deal of mass storage in the character generators.

Standby power generators can be fed with propane, gasoline or natural gas; the decision to use one fuel over another should be carefully considered. In any case, the generator must supply enough power to run every piece of gear, present or future, in the headend. Power wiring should be arranged so that the headend circuits, lighting and air-conditioning are all fed by the generator.

Determining air-conditioning capacity is not too difficult after figuring how much power is needed. Air-conditioning requirements are figured in btu (British thermal units). The formula generally used is:

$$\text{btu} = \text{total wattage in the headend} \times 3.41.$$

One ton of air moving capacity equals approximately 12,500 btu. Five tons or more of capacity is not uncommon in modern headends. Some engineers prefer to use two small air-conditioning units to increase efficiency and prevent total loss of cooling in the event of a failure. Consider room shape and rack placement to determine air flow and place air-conditioning (AC) units or vents accordingly. As noted before, venting underneath a computer floor and up into the racks is a very efficient method of controlling equipment temperature. If necessary, consider the services of an HVAC specialist.

One last, extremely important factor in this category is grounding. A headend cannot be overgrounded; every effort should be made to assure total grounding of this facility. Racks should be tied together using a tinned, braided wire rope or #6 soft drawn copper wire and bonded to AC ground. The AC ground also is bonded to the tower and earth station ground grids by #6 wire. It also is a good idea to bond individual pieces of equipment to the grounding system as well. Don't skip anything in making sure the headend is grounded.

Do it yourself or turnkey

The last planning step is deciding whether you are going to build the headend yourself or have it pre-built and shipped to your site already wired up. There are benefits, as well as drawbacks, to both approaches. The one major benefit of doing it yourself is that you have control over the whole process and know the headend inside out. Doing it yourself is very time-consuming though, so if you have anything else at all to do, like eat or sleep, it might be wise to look at a pre-built headend.

Pre-builts come fully wired and usually all that is required to install and connect the individual pieces. Obviously, a pre-built unit will be more expensive and even though they are supposed to be pretested, my experience has been that *everything*, including the connectors and passives, should be thoroughly checked and tested before going on-line.

When you are finally done, you should have a quality headend producing quality pictures. Proper planning will result in fewer delays, smaller headaches and a better end-product. ■

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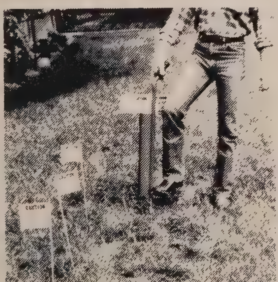

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The history of CATV

By Rikki T. Lee

Cable TV wasn't always the kind of service many of us take for granted today, with a plethora of satellite-delivered signals, channel capacities to match and addressability. In fact, the first 25 years or so of its history, "CATV" meant "community antenna television" and was used to bring to remote towns (for a monthly charge) the same broadcast stations that the nearby large cities were receiving free.

Communities in several states claim to have started the first CATV system, including ones in Oregon, Arkansas and Pennsylvania, and the topic is hotly debated to this day. However, most people in the industry believe that the distinction goes to Lansford, Pa., nestled in the Panther Valley area of the Blue Mountains. Here, a group of radio and appliance dealers, led by Robert Tarlton, unhappy about lack of sales of television sets (due to zero reception of three TV stations from Philadelphia), joined forces in 1948.

The plan was simple: Build an antenna tower at nearby Summit Hill, string RG-11U coaxial cable down telephone poles on the hill and distribute the signal through the town. To boost the signal, three Jerrold amplifiers were situated 2,000 feet apart down the hill. A network of coaxial cable and taps sent the signal into the neighborhoods.

After signing contracts with the telephone and power companies, the CATV system began operation. A school holiday was declared the day the system was turned on in 1949. TV sets began to be sold, and 100 homes signed up for the new CATV service. The installation fee was $100 with a monthly service charge of $3. Cable television was born.

In the early days, cable wasn't exactly the well-oiled machine it is today. According to Len Ecker, a pioneer in the cable industry and presently a consultant, "Most of the subscribers were fortunate if every time they turned on the TV set they had any kind of picture. I would estimate that roughly 35 to 40 percent of the time, the cable wasn't working at all."

Not far away from Panther Valley and at nearly the same time, in Mahanoy City, Pa., John Walson, another appliance store owner, strung twin-lead cable from a mountain antenna he had erected. Walson's CATV service had over 700 subscribers by the middle of 1948.

Maintaining the headend and antenna atop the mountain proved to be dangerous for some technical personnel. As Ecker reports, "We had no roads down our mountain, just a 7,000-foot run. And the side of that mountain was literally alive with snakes. I did get bit on the ankle by a rattlesnake once. We used to have to replace the cable rather frequently because it would get chewed up by bears."

Meanwhile, in Astoria, Ore., Ed Parsons was involved in similar efforts to bring in TV signals from Seattle. He set up his antenna atop a local hotel and strung twin-lead cable to his subscribers.

Although these and other CATV systems started around the same time (late 1940s) and achieved the same results, the major differences between the Lansford system and many of the others were a fee for subscribing and the type of cable used. Subscribers in other communities received the CATV service free if they bought a TV set from the town's only appliance store (more often than not, the owner of the CATV system).

Building the system really wasn't a top-secret operation. Rex Porter of Pyramid Industries assisted in the construction of several CATV systems in the late '50s and recalls, "I was making a signal survey on a mountain near this one Kentucky town, which was located in a little bowl at the foot of the mountain. But they had no TVs or TV reception. I used a GE Portacolor, a 12-inch color set. As I walked around the panel truck, paying attention to what I was doing, I noticed these people coming up the mountain in their cars.

"They parked and set their folding chairs right by my television. They were bringing food over to me and saying, 'Could we get you not to change the antenna setting until the program's over with?' When I finished my survey, it was one in the morning. I think there were 60 people making a semicircle around my portable TV set. They stayed until the stations went off the air. This was their introduction not only to a CATV system but to television itself."

In a small town, everyone knew the cable operator personally. Says Ecker, "One brisk fall morning, one of my subscribers jumped in front of my car and stopped me, complaining bitterly that the night before the TV had gone off at eight. He sat in front of the set for two hours before he gave up. He asked me what I was going to do about it."

CATV marches on

In 1948, faced with an increasing number of broadcast stations, the Federal Communications Commission decided that to ensure equitable allocation of available frequencies no new licenses would be granted. This freeze added to the complaints of those not in populated areas about the inability to receive signals.

It also boosted the increase in the number of community antenna television systems. By the time the moratorium was over in 1952, 70 CATV systems served over 14,000 households. Three years later, there were over 400 systems with a total of 150,000 subscribers.

The early CATV systems were neither regulated nor licensed by the FCC, since these systems merely amplified and distributed signals. However, during the '50s, some systems began importing distant signals of independent stations via microwave relays.

Also, a few cable operators experimented with pay TV. According to Ecker, "The first pay TV system was in Bartlesville, Okla. It was computer controlled and would let people pay only for what they watched. You could watch the movie for six minutes and 59 seconds. If you turned it off before the seventh minute came up, you wouldn't have to pay for it.

"The computer we used filled up a reasonable sized room. It took that computer seven minutes to go through a 16,000-subscriber base; it had to do with computer speed, not marketing. I don't think we ever admitted that to anyone; people thought we were clever."

These new and unregulated activities by the cable operators angered the owners of broadcast stations. By the end of the '50s, when over 600 cable systems were in operation, broadcasters began to clamor for some kind of control of cable. The FCC's first action in 1962, the *Carter Mountain Transmission Corp.* decision, began the regulation of cable's use of microwave transmission. In 1965, the commission established jurisdiction over all microwave-fed cable systems.

The FCC's *Second Report and Order* of 1966, later upheld by

the Supreme Court, placed restrictions on cable systems in the use of microwave relays to import distant signals. This in effect "froze" development of cable systems for over six years, when a more lenient regulation of cable was initiated by the FCC.

"This was just the start of the 12-channel system and the start of transistors," recalls Porter. "I went to work in Huntsville, Ala., and all their systems were low-band and had RG-11 trunk and RG-6 feeder cable. Nowadays those are just drop cable; but back then, that's what they had for trunk and feeder.

"All of the cable at that time," Porter remembers, "the trunk and feeder, had copper wire semiconductors. There wasn't such a thing as copper-clad aluminum semiconductors. So they were quite expensive. In '68 we had a shortage, due to a copper workers' strike, and you couldn't get RG-59. As a matter of fact, it was so bad, people were buying every source of scrap cable they could find. They'd offer to buy it from you for twice what you paid for it, then send you a letter saying that after the strike they'd give the cable back to you."

With the 1972 reduction of federal regulations, cable systems began to grow once again. And in 1973, the domestic communications satellite was approved by the FCC. The following year saw the launch of the first U.S. geostationary satellite, positioned 22,300 miles above the equator and revolving at the same speed as the Earth.

Perhaps the biggest event in cable history took place in 1975 with the launching of the RCA satellite Satcom I. A small premium service called Home Box Office was the first to transmit its signal via satellite. With this new technology, the number of cable subscribers more than doubled in six years, to nearly 20 million in 1981. (Prior to this, some programming was distributed or "bicycled" from city to city.)

Changing technology

The number of orbiting satellites (and, hence, transponder space for programmers) grew. Cable operators needed new, sophisticated technology to receive, transmit and (later) decode the signals. More and more urban areas began to build, earth station "antenna farms" sprang up and headends added extra racks of new equipment.

And coaxial cable changed, too. In 1964, foam dielectric cable contained a small center conductor and assured a bandwidth of 50 to 216 MHz. Ten years later, the first generation gas-injected polyethylene cable appeared, assuring a bandwidth of 5 to 300 MHz. Again, 10 years later, the fourth generation gas-injected polyethylene cable was the first to feature a core-to-center conductor and sheath-to-jacket bonding, assuring a bandwidth of 5 to 600 MHz.

Finally, subscriber equipment changed and expanded, offering programmable remotes with volume control and event-ordering capabilities, addressable converters with parental lockout, and VCR and stereo hookups.

And what of the future of cable TV? The possibilities seem almost endless: rebuilding with fiber-optic cable, ever-expanding capacity, new subscriber services like impulse pay-per-view and impulse home shopping, hookups to personal computers, and, who knows, perhaps even two-way holography. ■

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Basic electronics theory

This is Part II of a series about basic electrical and electronic principles, designed for the individual with little or no training in either electricity or electronics.

By Kenneth Deschler
Cable Correspondence Courses

This month we will introduce you to a device known as a *resistor*, a component used to limit the amount of current flowing in an electrical circuit. We can define an "electrical circuit" as an arrangement of one or more complete paths for current flow. We'll also cover the resistor color code, metric units and Ohm's law relationships between voltage, current and resistance.

Fixed and variable resistors

Resistors are electrical components that are made to have a specific amount of resistance. In our last lesson, we learned that the resistance of a wire conductor increases with its length and thickness. By winding a conductor around an insulated form, we can make a resistor of almost any value we desire. This type is called a *wirewound* resistor. Wirewound resistors can be manufactured with very accurate values of resistance. Because of the limitations of physical size, wirewound resistors are not able to exceed 15,000 ohms. (As a general rule, the word "ohm" is not used after the value of a resistor, but rather the Greek symbol Ω is used instead. Therefore, the limit of wirewound resistors is written 15,000 Ω.) Wirewound resistors may have one or more taps along their length in order to obtain different values of resistance from one unit.

Figure 1: Types of resistors

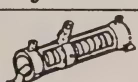
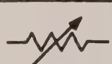
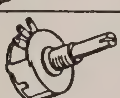
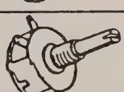
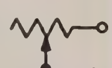
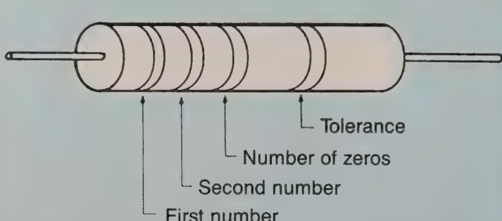
Typical resistor	Type	Symbol
	Fixed carbon	
	Fixed wirewound (tapped)	
	Adjustable wirewound	
	Potentiometer	
	Rheostat	

Figure 2: Color coding on a resistor



Two others types of fixed resistors are *carbon composition* and *deposited film*. A carbon composition resistor is made by combining carbon or graphite with a filler material such as bakelite and forming it into the shape of a cylinder. Wire leads are then inserted into each end, and the mixture is dried and coated with an insulating material.

A carbon composition resistor is shown in Figure 1. By varying either the distance between the ends of the leads within the mixture or its composition, different values of resistance may be obtained. Deposited film resistors are made by coating an insulated rod with a metal film. Affixed to each end of the rod is a cap and wire lead to allow connection to an electrical circuit. Carbon composition and deposited film resistors can be made in values up to 100 million Ω.

Because of the heat generated by current flowing through resistors, they are made in various physical sizes and shapes and have a wattage rating along with their ohmic value. Common values of wattage rating extend from one-tenth of a watt to as high as 100 watts. A *watt* is the unit of measure of electrical power and is found by multiplying the voltage times the current. The symbol for watt is W.

The most common way of obtaining a variable resistor is to form either a block of carbon composition material or a coil of resistance wire into a loop and attach a wiper arm to move over its surface. In this way any value of resistance may be obtained from zero to the maximum value of the resistor. An example of a variable resistor is the volume control on a TV receiver. Two types of variable resistors are shown in Figure 1.

Resistor color code

In order to mark resistors with their ohmic values, manufacturers either paint color bands or stamp the value on the body of the resistor. Generally wirewound resistors are stamped; carbon composition and deposited film resistors are color-coded with color bands. Figure 2 depicts a carbon composition resistor with four color bands to designate its ohmic value and tolerance. Tolerance is the amount above and below the coded value by which the resistance is allowed to deviate. As can be seen, the first three bands are located close to one end and the fourth band is situated close to the center of the resistor's body. Reading the code is done by recording the number value of each band. The numerical values of the various colors are:

Black	=	0	Blue	=	6
Brown	=	1	Violet	=	7
Red	=	2	Gray	=	8
Orange	=	3	White	=	9
Yellow	=	4	Gold	=	5 percent
Green	=	5	Silver	=	10 percent

In Figure 2 the first band (closest to the end) signifies the first number, the second band the second number and the third band the number of zeros. Imagine that the first band is blue, the second is yellow and the third is red. By decoding the colors we find that a resistor coded blue, yellow and red is 6,400 Ω. Remember, the third band is not a number but rather the amount of zeros after the two numbers. If the third band is either gold or silver, then the value of the resistor is 5 percent (0.5) or 10 percent (.1) of the value of the first two numbers. For example, a resistor coded blue, yellow and silver would be 64 times .1 or 6.4 Ω.

The fourth band shows the resistor's tolerance value. For example, a resistor coded blue, yellow, red and silver would have a value between 5,760 and 7,040 Ω. If the fourth band is missing, the tolerance is 20 percent of the coded value of the resistor.

Metric units

Metric units are used in electronic work to designate very large or very small quantities of voltage, current, resistance and power. Metric units also are used to designate sizes of other components in electronic circuits. The more common metric designations and their values are as follows:

mega (M) = 1 million
kilo (k) = 1,000
milli (m) = one-thousandth
micro (μ) = one-millionth
nano (n) = one-billionth
pico (p) = one-trillionth

Examples include:
5,000 watts = 5 kW
.003 volts =3 mV
.000007 amperes = 7 μA

Ohm's law

Ohm's law is the relationship between voltage (E), current (I), resistance (R) and power (P) in an electrical circuit. Figure 3 is an Ohm's law wheel, a collection of formulas used to find an unknown electrical quantity if two other quantities are known. Let us now use some of these formulas in the following examples:

Example #1: How much current is used by a toaster? Answer: First write down the amount of watts listed on the nameplate of your toaster. Second, write down the voltage required by the toaster. Next, find the segment of Figure 3 containing the letter "I" (current). We see that only one formula can be used when we know voltage (E) and power (P):

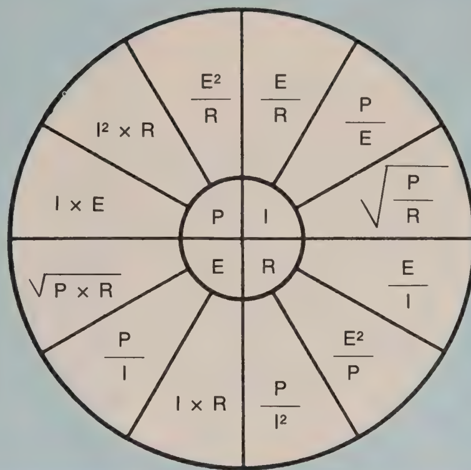
$$I = P/E$$

By substituting the values obtained from the nameplate we can find the amount of current used by the toaster. Let's say the toaster uses 1,500 watts of power and is connected to 120 volts. So:

$$I = 1{,}500/120$$
$$= 12.5 \text{ amperes}$$

Example #2: What is the resistance of a 100-watt light bulb? Answer: According to the markings on the bulb, 120 volts are required for illumination. Look for a formula from Figure 3 to obtain the resistance (R) when we have values of power (P) and voltage (E). That formula is:

Figure 3: Ohm's law wheel



$$R = E^2/P$$

The small number 2 above the value of voltage (E) means that it must be multiplied by itself. Substituting our known values, we find that the resistance of a 100-watt light bulb is:

$$R = (120 \times 120)/100 = 14{,}400/100$$
$$R = 144\ \Omega$$

Check yourself

1) What is the value and tolerance of a carbon composition resistor with color bands of green, violet, brown and silver?
2) What color bands are used to designate 37,000 Ω at 5 percent on a carbon composition resistor?
3) What is the most resistance obtainable with a wirewound resistor?
4) What is a watt?
5) Ohm's law is the relationship between ____________, ____________, ____________ and ____________.

Next month we will learn the symbols used in circuit diagrams and explore series DC circuits. ■

Answers to quiz
1) 570, 10 percent
2) Orange, violet, orange, gold
3) 15 k Ω
4) The unit of electrical power
5) Voltage, current, resistance, power

Correction

In last month's "Basic electronics theory," the final sentence on pg. 22 should read: "The unit of current is the *ampere* (A); opposition to current flow is called *resistance*, which is dependent upon cross-sectional area (thickness), length, temperature and the type of material used." We regret any confusion that the error may have caused.

Recycling resources

By Tom Wood Jr.
Accounts Manager, Resource Recovery Systems

The main purpose of the cable TV companies is to sell programming to subscribers whose monthly fees enable the systems to make a profit. What better way is there to help ensure the industry's success than saving money, whenever and wherever possible, and passing those savings along to the consumer? As in any business the blatant waste of capital and resources, resulting in an escalation of costs, is a sure-fire formula for eventual failure. Why then does the cable industry think it is any different in its ability to operate efficiently with such flagrant extravagance?

Millions and even billions of dollars are spent every year on cable system construction, both new and rebuild, most of which is expended on labor and materials. Go into most system headend yards (or their contractors'), however, and chances are you will see an unsightly accumulation of wooden cable reels, coax cable and electronics either lying on the ground or in the trash dumpster.

Ask any director of construction or engineering and he will tell you that this type of material is not only part of the expected and accepted 5 to 10 percent "waste factor," but is even budgeted for! Materials such as aluminum, copper and plastic, whose scrap value has never been higher, are being systematically hauled to landfills and dump sites (those that will still take them) around the country.

Not only are the cable systems missing out on the potential revenue to be garnished by the sale of these salvageable materials, they are also spending the high labor costs of using technicians or their contractors to dismantle reels and load cable into their trash dumpsters. These dumpsters can cost over $600 per load in some parts of the country.

Anyone who has dealt with the problem can tell you that it doesn't take very many reels (even disassembled) to fill even the largest of trash boxes. In many areas, particularly the Northeast where these costs tend to be the highest, the trash hauling

companies and the landfills are even refusing to accept such bulky items...at any price.

Far too often the construction and engineering people are too busy with the details of actually building the system and all the hassles that entail to appreciate the problems awaiting them with the disposal of leftover or unusable construction materials. Piles of partial reels of cable or miles of wrecked-out coax with steel strand and lashing wire have been known to actually halt construction until a solution could be found...a nightmare for the system as well as its aerial and undergrond construction contractors.

These same contractors are often the ones burdened with the responsibility for disposing of the scrap but, unless handled turnkey, without benefit of the rights to the sale thereof. Consequently, they can hardly be held accountable for not caring what happens to these materials once they are removed.

The solution, obviously, is to be able to predict this type of situation before it ever occurs. Preplanning for this eventuality in advance of construction can prove prudent in more ways than one. It's relatively easy to flip open any Yellow Pages and look under "Trash Hauler" or "Scrap Dealer" as a temporary solution to the problem. Do these people, however, understand the cable business? Are they geared to handle the specific needs of the system? Are they reliable and can they be trusted to provide not only a service but pay for the recyclable materials they are entrusted to remove? More often than not, unfortunately, the answers are "no."

Careful screening and attention, not only to bid rates but also to performance history, are given to those construction contractors enlisted by the cable company in the handling of their new materials. Why then are not the same prerequisites required of those handling the system scrap?

As with any service organization, "you get what you pay for." Those companies who are either not prepared to pay for materials removed or who want the system's personnel to do all the work (disassembling reels, loading cable, etc.) are hardly offering a "service." Likewise, those companies who bid the highest price and are willing to do the work may only be able to quote that price, knowing that they have no intention of actually paying or possibly paying for only part of what they have hauled away.

All too often those same individuals who are so concerned about the "highest bid" from a salvage contractor at the beginning of a build are content to accept such second-rate service or blatant thievery rather

than make a change or face a yard full of scrap. As long as the mess is kept up, the construction personnel are content while the cable system misses out on thousands of dollars of potential revenue. Unlike signal theft, which represents lost potential revenue, every pound of cable that the system does not utilize in its construction or is not paid for in scrap recovery is an actual out-of-pocket expenditure that has to be accounted for somewhere.

Resource Recovery Systems has been handling only those non-usable, salvageable materials from cable TV system construction for over four years. We also handle the scrap from new and rebuild construction simultaneously from numerous locations around the country. In addition, RRS has dealt with the various cable manufacturers in the implementation and continuation of their various reel recycling programs.

Disassembly and disposal of the wooden reels is one of the most costly aspects of handling the salvage from any cable build. By providing the labor to assemble, strip and prepare the reels for shipment back to their manufacturers, RRS provides a unique service in the industry...at no charge to the system! This is certainly an attractive alternative to spending thousands of dollars in disposal costs to have these materials hauled to cost-prohibitive landfills and dump sites.

The concept of revenue generated from the sale of non-usable construction materials being sufficient for ''party'' or ''picnic funds'' is an incorrect but understandable one. For years the systems have been paying to have these saleable materials hauled away as trash. If they ever got paid at all, it was so little that it would just about cover the cost of a few beers or some barbeque.

Proper monitoring of the scrap as well as the contractor assigned to handle it, however, will ensure much more in the way of actual in-pocket return. A 10 percent ''waste factor'' on $1 million dollars worth of construction materials is $100,000... quite a nice party budget! Resource Recovery Systems has paid out hundreds of thousands of dollars in reimbursement for materials handled from systems around the country.

One of the main problems seems to be that of education. Those individuals who are in charge of monitoring or disposing of the scrap are not always in a position to attend the trade shows or do not always read the trade publications and their advertisements to know who is available. It then becomes the responsibility of corporate engineering, construction or even purchasing to ensure that the various system-level people know who they can contact in advance of construction to prevent downtime and lost revenue.

Resource Recovery Systems has always made it a point to copy the corporate office of any system they handle scrap from. In addition to helping corporate keep track of where the monies are coming from, it also helps them monitor acceptable levels of scrap being generated from any particular system. After all, the most efficient utilization of these expensive construction materials is in the transmission of cable TV signal and not in being melted for scrap!

In today's economy, all industries are finding that waste control can spell the difference between success and failure. The United States, with the reputation as the most wasteful nation in the world, is being confronted with increasingly massive disposal problems such as the cost, not only of disposal, but also the cost of *not* conserving our recyclable resources. It is therefore the responsibility of the cable TV industry to set an example in the proper handling of their own scrap materials in their communities. ■

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- BTSC Stereo Compatibility
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(Note: The advertisement on the previous page is the 550 MHz frequency agile Commander 5 modulator. For those operators requiring less bandwidth, Jerrold also offers the frequency agile S300M. Installation of that modulator is explained in this advertorial.)

Cost-effective headend processing equipment for cable and SMATV operators

By Bill Beck and Chuck Dougherty
Jerrold Distribution Systems Division

Realizing the need of cable and SMATV operators for headend equipment that provides optimum performance at a reasonable price, Jerrold offers the "S" series line of signal processing equipment. The product line includes the:

- S300M frequency agile 300 MHz modulator
- S450P frequency agile up- and down-conversion heterodyne processor
- S890D frequency agile demodulator
- S412R-7 C-/Ku-band selectable satellite receiver

Agility, it is apparent, is the common denominator in the product line. This philosophy permits the operator the maximum flexibility of setting his channel carriage and simplifying spares since one device serves as standby for all. This article will present the features and operational setup of the S300M.

S300M overview and features

The S300M is a frequency agile modulator that employs frequency synthesized LOs (local oscillators) in a dual upconversion to provide image-free outputs. The modulator can be configured for any channel output between 2 and 36 inclusive.

Frequency offsets of +12.5 kHz and +25 kHz are programmable from the front panel. This feature, combined with the 5 kHz stability, make the S300M completely FCC compliant with Section 76.612.

The S300M also provides an HRC assignment, if desired, for standby operation. (Note: The S300M cannot be locked to a comb generator and therefore should not be considered for HRC FCC compliance).

With respect to channel carriage, the S300M also provides a spectrum inversion feature that may be employed by those operators using spectrum inversion as a soft scrambling technique.

Separate IF loops for picture and sound are provided for sync suppression scrambling. In addition, the S300M employs SAW filter technology to maintain a quality vestigial sideband response and eliminate any possibility of adjacent channel interference.

The S300M is stereo compatible. A baseband BTSC-encoded audio or 4.5 MHz aural carrier may be used as an input.

The modulator was designed to conserve rack space. The physical dimensions are 8 inches deep × 19 inches wide × 1.75 inches high. Depth of modulation and audio deviation have front panel adjustments and indicators. An RF test point (−20 dB) and level adjustment are also available from the front panel.

Figure 1: Standard channel assignments

	Freq.	DIP switches													
Ch.	in MHz	1	2	3	4	5	6	7	8	9	10	1	2	3	4
2	55.25		UP			UP	UP	UP					UP		
3	61.25		UP		UP				UP				UP		
4	67.25		UP		UP	UP							UP		
5	77.25		UP		UP	UP	UP		UP				UP		
6	83.25		UP		UP	UP	UP						UP		
7	175.23	UP				UP		UP					UP		
8	181.25	UP				UP	UP		UP				UP		
9	187.25	UP			UP								UP		
10	193.25	UP			UP			UP	UP				UP		
11	199.25	UP			UP		UP	UP					UP		
12	205.25	UP			UP	UP			UP				UP		
13	211.25	UP			UP	UP	UP						UP		
14	121.2625		UP	UP		UP	UP	UP	UP						
15	127.2625		UP	UP	UP			UP							
16	133.2625		UP	UP	UP		UP		UP						
17	139.25		UP	UP	UP	UP							UP		
18	145.25		UP	UP	UP	UP		UP	UP				UP		
19	151.25		UP	UP	UP	UP	UP	UP					UP		
20	157.25	UP							UP				UP		
21	163.25	UP					UP						UP		
22	169.25	UP					UP	UP	UP				UP		
23	217.25	UP			UP	UP	UP	UP	UP				UP		
24	223.2625	UP		UP				UP							
25	229.2625	UP		UP			UP		UP						
26	235.2625	UP		UP		UP									
27	241.2625	UP		UP		UP		UP	UP						
28	247.2625	UP		UP		UP	UP	UP							
29	253.2625	UP		UP	UP				UP						
30	259.2625	UP		UP	UP		UP								
31	265.2625	UP		UP	UP		UP	UP	UP						
32	271.2625	UP		UP	UP	UP		UP							
33	277.2625	UP		UP	UP	UP	UP		UP						
34	283.2625	UP	UP												
35	289.2625	UP	UP					UP	UP						
36	295.2625	UP	UP				UP	UP							
54	73.25		UP		UP		UP	UP	UP				UP		
55	79.25		UP		UP	UP		UP					UP		
56	85.25		UP		UP	UP	UP		UP				UP		
57	91.25		UP	UP									UP		
58	97.25		UP	UP				UP	UP				UP		
59	103.25		UP	UP			UP	UP					UP		
60(A-2)	109.275		UP	UP		UP			UP					UP	
61(A-1)	115.275		UP	UP		UP	UP							UP	
		1	2	3	4	5	6	7	8	9	10	1	2	3	4

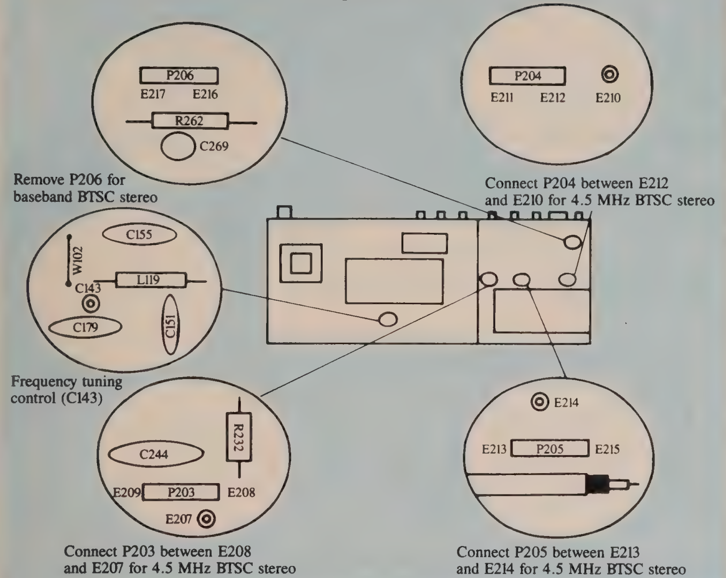
Configuration

The S300M must be configured for its proposed application prior to being placed on line. The first step is to set the operating output frequency.

Behind the sliding protective cover are 14 DIP switches. The switches are clustered in one group of 10 and one group of four. Figure 1 is a matrix showing the position of the DIP switches for standard frequency assignments. (An HRC frequency scheme also is sent with the unit.)

To begin the configuration set all the switches in the down position and select the channel you desire for an output. For example, if Channel 25 were desired, switches 1, 3, 6 and 8 would be moved up.

Figure 2



If spectrum inversion were desired. the very last switch would be moved up. (Note: The spectrum inversion switch should only be moved when the S300M is powered down.)

Next, record the DIP switch positions in your headend log. This will ease the return to the proper frequency should the modulator be unknowingly adjusted. Place the self-adhering sticker for the appropriate channel to the front panel slide.

Next, if BTSC stereo is to be used on the channel, remove the top cover. Figure 2 shows the relative position of the jumpers needed to configure the unit. The jumper positions shown are for normal operation. If baseband BTSC stereo is to be used, remove suitcase jumper P-204 and reinstall the lid. If the stereo is to be inserted at 4.5 MHz, relocate the following jumpers between the associated pins.

Jumper	Pins
P-204	E-210 and E-212
P-205	E-213 and E-214
P-203	E-207 and E-208

Reinstall the cover at this point.

This completes the configurations of the S300M for your application. Please note that the frequency assignment matrices are affixed to the top cover of the modulator for your convenience.

Operational setup

Allow a 24-hour warm-up period prior to installation into the system. After all connections have been made (i.e., video input, audio input, RF out and IF loops) S300M is ready for parameter adjustment.

With a diddle stick through the front panel, adjust the depth of modulation until the associated LED illuminates. Then back off until the LED goes out. At this point, the unit is set for 87.5 percent depth.

If standard audio is being used, adjust the audio deviation to match the volume of loudness of an off-air channel. If no off-air processing is being done, install a 400 Hz tone into the audio input and adjust the audio deviation until the associated LED illuminates. Again, reduce the deviation until the LED goes dim. At this point the unit is set for 25 kHz deviation.

With an SLM and PMG-61F adapter set the RF output level and picture-to-sound ratio (−15 dB) through the front panel test point (−20 dB). The S300M is now operational.

Conclusion

This discussion has presented the S300M modulator. It is the first in a line of products developed by Jerrold for maximum flexibility through frequency agility and conservation of high quality performance and rack space through innovative low-profile design. ■

Specifications

Video input level	0.7-1.4 V p-p
Audio input level	−10 to +10 dBm at 600 ohms
RF output level	60 dBmV min., 10 dB adj.
Spurious output	at least −60 dB at 60 dBmV
Power	108-132 VAC 35 watts

(Additional specifications available upon request)

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July	Construction Practices
August	Transportation Systems (Microwave and Fiber Optics)
September	Distribution System Design, Grounding, Power Supplies
October	Distribution System Actives and Passives
November	Taps, Drops, Splitters, Traps
December	Installation, Converters, VCR Connections

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Troubleshooting • Installer Input • Safety on the Job

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Employees or independent contractors?

By Joseph Govern
Vice President of Finance, NaCom

This advertorial addresses the dilemma often facing prudent managers in the cable television services industry: "Should we hire more employees to meet our installation and technical services requirements or should we select an independent contracting company?" Too frequently and at the expense of the profitability of a system, the choice is automatically made to hire more employees without thoroughly evaluating the alternative of the independent contracting company.

What are the factors to be considered in this decision-making process? Certainly, direct and indirect costs are important, as are the level of service desired, short-term vs. long-term requirements, action response time and availability of qualified persons to hire.

Cost factors to be considered fall into two categories: direct and indirect.

Direct costs most easily recognized:
Wages of the employee and supervision expense
Overtime costs
Vehicle
Vehicle maintenance
Tools

Indirect costs not always recognized:
Payroll preparation costs
Hiring and firing costs
Training and orientation expenses
Employee fringe benefit program costs; e.g., health insurance, retirement, etc.
Workers' and unemployment compensation costs
Federal, state and local tax administration and contributions
Business insurance expense
Vehicle insurance
Exposure to union organization
Liability for wrongful discharge; i.e., unlawful employment practices, defamation, etc.
Productivity and quality control management
Ancillary materials and equipment; e.g., paper, pens, two-way radios
Cost of warehouse, parking, workspace, restrooms, lunch facilities and related facilities such as telephone, etc.
Accounting and administrative costs to process and monitor the foregoing costs
The time-value of money

Compare the sum cost of all direct and indirect cost factors to periodic payments made to a qualified contractor who provides appropriate management and skilled workers and is compensated on the basis of work performed. Our studies show the difference can be as great as 44 percent in real dollar savings plus the benefit of transferring the burden of management to professionals whose primary business mission is the delivery of installation and technical services.

Similarly, the level of service desired and provided can be a function of a contractual arrangement. Professional contractors in the industry have internal facilities and the wherewithal to customize a training program to assure that the specifications of the client system are met. Quality assurance programs that work and timely response to system and subscriber concerns regarding the installation and/or service call are also characteristic of a professional contracting organization.

The duration of the requirement for supplemental skilled labor services is also an important factor in favor of the use of a contractor. This is particularly true of system requirements of two years and under. Many systems, however, have found it economically beneficial to continue with contractors indefinitely. For example, we have been engaged in one contract for over 14 years, except for a four-month interlude when the attempt was made to go "in-house." Higher than expected costs and significantly lower per-person production resulted in that system's decision to return to the use of a contractor. We have also experienced several other situations where a cable system elected to go in-house only to return to the use of an outside contractor six months to one year later after learning the actual costs and management headaches of operating a large scale in-house operation.

In discussing the total costs (both direct and indirect) of an in-house operation with financial executives of several MSOs, we have found that most cable systems' accounting systems are not capable of segregating costs attributable solely to installation and technical services. The lack of accurate historical cost data is the reason so many cable systems cannot accurately predict for budgeting purposes total costs, especially fixed costs, of operating large scale in-house operations.

Additionally, the action response time from recognized need to the beginning of the satisfaction of that need is frequently inadequate to allow for system personnel to hire, train and equip the necessary labor force. Generally, professional contractors are oriented for rapid mobilization to meet such occasions.

One of the byproducts of a vibrant economy is low unemployment rates. The Aug. 10, 1987, issue of *Business Week* highlighted this condition in an article titled "Help Wanted." Significant points made in this article are:

- Unemployment has fallen below 4 percent in 31 major metropolitan areas in 19 states.
- A slower growing population is propelling the country into a period of labor scarcity that could last until the turn of the century.
- The problem is compounded by a widening mismatch between the skills workers have and the skills employers need.
- Employers who can't find qualified applicants are boosting their training budgets and offering more basic and remedial education; others are raising wages.
- To keep wage costs in line, employers will have to boost productivity, which is already proving to be a tall order in most service industries. The easiest solution is to raise wages. After all, as with other shortages, raising the price tends to increase the supply, though it may not produce the quality of workers employers want.
- "If labor costs really start to shoot up, business will find ways to offset it," predicts Richard Belous, a labor economist. One way is to do a lot more about lagging service industry productivity.

Yet another perspective being reviewed by the business community and meeting with impressive positive reactions is the concept of employee leasing. In essence, this calls for terminating your current employees and then hiring them back from an agency that provides the services of dealing with the headaches and administration of the employees for cost plus a fee.

In reality, this is what professional contractors do while providing certain cost savings, the desired levels of service, meeting immediate need and providing and/or having access to qualified personnel.

For more information on this subject, please contact Joseph Govern, vice president of finance, or Randy Carpenter, director of marketing and customer service, at (614) 895-1313; or by mail to NaCom, 1900 E. Dublin-Granville Rd., Columbus, Ohio 43229. ■

Playing it safe with ladders

This is the second installment of a two-part series about ladder safety.

By the Society of Cable Television Engineers

It is strongly suggested that you use live demonstration techniques to show your employees how to handle ladders. Many of the following suggestions can be effectively backed up with demonstrations. Be sure to make necessary preparations as well as rehearse with the person who will handle the ladders. Also, be sure to have all tools or equipment necessary for the demonstration.

The following demonstrations are suggested:

1) Clearance space for climbers on fixed ladders.

2) Correct pitch of fixed ladders.

3) Correct overlap procedures of extension ladders.

4) Correct procedures for raising or lowering tools and materials from extension ladders.

5) Lashing the ladder to the strand.

6) Placing portable ladders the correct distance from wall to work surface.

Fixed ladders

A fixed ladder is a ladder that is permanently attached to a structure, building or equipment. The federal government considers steps on poles and communications towers in this category.

1) Fixed or permanent ladders should be maintained in sound, usable condition and kept free of grease and other agents that might cause slipping.

2) When space is available, a fixed ladder should extend at least 3 feet above the highest landing.

3) The spacing of steps permanently installed on poles, ladders or towers should be no more than 12 inches apart (24 inches on any given side) and should be uniform above the section without steps (except where working, standing or access steps are required).

4) The spacing of detachable steps should not exceed 30 inches and should be properly secured when in use. Steps should have a minimum clear width of 4½ inches.

5) The minimum design live load is 200 pounds for each person anticipated to be on the ladder at any given time.

6) Rungs, cleats and steps must be free of splinters, sharp edges, burrs or projections that could be hazardous.

7) Side rails that might be used as a climbing aid should be of such cross sections as to provide adequate gripping surface without sharp edges, splinters or burrs.

8) Splices must not have sharp or extensive projections.

9) Care should be taken to see that two metals that could cause electric shock are not used together.

10) Ladders must be protected from corrosion, rusting, decay or harmful effects of one material against another.

11) Clearance on the climbing side for a climber on a 90° pitch ladder should be 30 inches from the rungs.

12) Clearance in back of a ladder should be no less than 7 inches from the centerline or rungs to nearest permanent object in back of the ladder.

13) There must be a clear width of 15 inches from the centerline of the ladder in the climbing space except where cages or wells are necessary.

14) Clearance in back of a grab bar must not protrude on the climbing side beyond the rungs of the ladder they serve.

15) The step-across distance from the ladder to equipment or a structure should be a maximum of 12 inches and a minimum of 2½ inches. If the distance exceeds 12 inches, a landing platform should be provided.

16) The side rails of through or sidestep ladder extensions must extend 3½ feet above parapets and landings. For through ladder extensions, the rungs should be omitted from the extension and must have not less than 18 nor more than 24 inches of clearance between rails. For sidestep or offset fixed ladder sections, at landing, the side rails and rungs must be carried to the next regular rung beyond or above the 3½ foot minimum.

17) Ladder safety devices such as life belts, friction brakes and sliding attachments may be used on tower, water tank and chimney ladders over 20 feet in unbroken length instead of a cage or platform.

18) The preferred pitch of fixed ladders is 75° to 90° from the horizontal position.

19) Fixed ladders installed between 60° and 75° from the horizontal position are sub-standard and such installation is to be avoided.

20) Pitch in excess of 90° from the horizontal position is prohibited.

"When using a ladder on a strand having a fairly steep slope, the ladder should be held by another employee or secured with a rope."

Extension ladders

An extension ladder is a non-self-supporting portable ladder adjustable in length. It consists of two or more sections traveling in guides or brackets arranged so as to permit length adjustment.

1) When extending or lowering extension ladders, the employee should keep his hands on the side rails, never on the rungs. Once the ladder has been extended, it should be locked into place before use.

2) On a two-section ladder, allow a minimum lap of 3 feet for ladders up to 36 feet long. For ladders 36-48 feet in length, allow a minimum lap of 4 feet, and, for ladders 48 to 60 feet long, allow a minimum lap of 5 feet.

Ladder length	Extension overlap
36 feet	3 feet
36-48 feet	4 feet
48-60 feet	5 feet

3) Tools and materials should be raised and lowered by means of a hand line while working on extension ladders.

4) When used on aerial plants, extension ladders should be securely lashed to the strand, or guarded by an employee at the bottom of the ladder.

5) Where strand hooks are used and the ladder is not being used as a ceiling

ladder, lashing is not necessary.

6) When using a ladder on a strand having a fairly steep slope, the ladder should be held by another employee or secured with a rope to prevent the top of the ladder from sliding along the strand.

7) Extension ladders having defective pull ropes should not be used until the rope has been replaced.

8) Safety belts should be worn when working from an extension ladder.

Step ladders

A step ladder is a self-supporting portable ladder, non-adjustable in length, having flat steps and a hinged back. The size of the ladder is determined by the overall length of the ladder measured along the front edge of the side rails.

1) Care should be taken to see that spreaders are fully extended and locked before climbing. A step ladder must *not* be used in place of a straight ladder.

2) Defective ladders (missing such items as spreaders or steps) must *not* be used.

3) Employees should not stand on the top step of a step ladder. When the ladder is not high enough for the job, get a higher step ladder or use another type of ladder.

4) Tools or materials should not be placed on the steps of ladders.

Portable metallic ladders

The use of portable metallic ladders for work on or near any electrical equipment is prohibited. These ladders should always be clearly labeled with a warning against their use on or near electrical equipment.

1) Maximum lengths: step ladders—20 feet; single straight ladder—30 feet; and two-section extension ladder—48 feet.

2) The bottoms of the four rails are to be supplied with insulating non-slip material. Ladder rungs should be coated with a non- skid material or be corrugated.

3) Step ladders must be equipped with a metal spreader or locking device to secure front and back sections in an open position.

4) Ladders transported on vehicles must be properly supported by a softer material, such as hardwood or a rubber-covered iron pipe, to minimize chafing and the effects of road shock. Tying the ladder at each supporting point will greatly reduce damage due to road shock.

5) Regularly inspect the following items and clean or replace the defective part or entire ladder as required: hardware, fittings, accessories, ropes, cables, side rail connections or bends, excessively dented rungs, rung-to-side rail connections, rivets and acid or alkali damage. *Ladders must be kept clean and free of oil or grease.*

6) For non-self-supporting ladder angle, place the base a distance from the vertical wall equal to one-fourth the length of the ladder.

7) Design load limits for ladders is *one* 200 pound person.

8) Ladder base must be placed with a secure footing. Safety shoes should be installed on all ladders.

9) The top of the ladder must be placed with two rails supported.

10) When ascending or descending, the climber must face the ladder.

11) Extend ladders with manufacturer's fittings, not with makeshift rope tied to provide a longer section.

12) Do not use ladders for brace skid guy, gin pole, gangway and other uses not intended. ■

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How to plan a job

By Andy Jensen
Vice President Technical Services, Cable Consult Inc.

The first thing to be done on any job, whether it is an installation or a service call, is to organize yourself and plan your job. Take the time to ensure that you know exactly what the customer is asking for and how you are going to do it.

The first step in doing the job occurs before arriving at the customer's front door. When you leave the shop in the morning check the work orders for the day to make sure that you have all of the tools and equipment that you will need for the day. In addition, have any special equipment you will need to do custom cable work, VCR hookups and stereo hookups (or anything out of the ordinary). Making sure that you have everything you need saves you the time it would take to "get them somehow" or the trouble of making do with what you have.

Once you have everything you need and you are at the customer's home, check with the customer to be sure that what you have on your work order is what the company was asked to provide. More often than not, there will be changes you should know about before you start working. Because customers are often unsure of what they want, be careful to go through the entire installation with them. Show the customer exactly where each outlet will be and how the cable will be run to that location. This reduces the chances that the customer will change his mind after the work is complete or that you will make holes or marks in the home that he did not want.

On site

Once you know exactly what the job is, decide how you are going to complete it. Begin at the beginning, which in most cases is the tap at the edge of the customer's property either on a pole or in an underground vault. Check to see that there are no obstructions in the path you are using to the house and that there is a place to attach the drop to the house. Also, make sure there is a place to ground the drop that is closer than the nearest TV outlet, preferably at or near the splitter location.

A good rule of thumb is to run the cable drop along the same line as the other utility drops (phone and power) and to locate the splitter near the same location as the phone box and power meter if possible. This is usually a more aesthetically pleasing way to run the lines—which makes your subscriber happy. As well, it provides you with at least one source of ground. Also, make a list of anything you will need to attach both ends of the drop.

Next, inspect the routes you will follow when installing the outlets. Make sure there aren't any obstructions along the way you cannot cross or areas where the cable will "stick out like a sore thumb." If you are planning to run cable under the house, make sure that there is access to the area. If more than one line is going to follow the same path for any distance plan to run them together to save time if possible.

In short, look at everything involved in getting the cable to the television locations and make any changes in your plan before you start working. Remember, if you have to do something other than what you discussed with the subscriber you should let him know before you start and get his approval. Again, once you have decided how you are going to run the cable, make a list of parts and supplies you will need to do the job so you don't have to run back to your truck midway through the job.

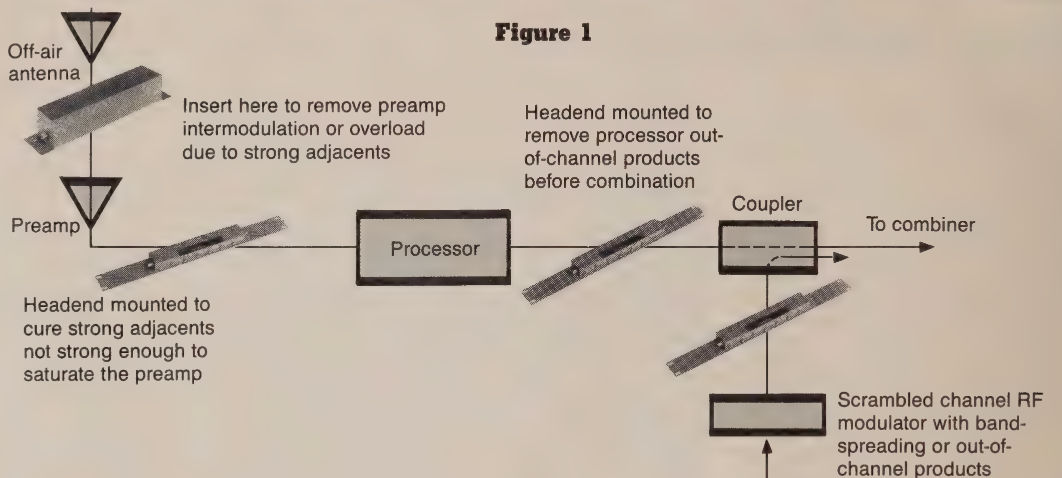
There is one last thing to check. If you are installing an unusually long drop or a large number of outlets there may not be enough signal to provide a good picture at every TV set. If you know how to calculate signal loss you need to do this to be sure that you can give your customer a good picture or make necessary changes in the installation to make this possible. If you don't know how to do this or if you think this might be a problem let your supervisor know so that he can help you with this. You will learn with experience how to do these more difficult designs, but in the meantime if you are not sure then ask someone.

"Because customers are often unsure of what they want, be careful to go through the entire installation with them."

These are the very basic steps to planning a basic installation, but the idea is the same for any type of job. Define exactly what you want to do, decide how you are going to do it and what tools and equipment you will need, and make all your decisions before you start. Your work will be right the first time. As you get into the habit of following a plan on every job you'll do them even faster. ■

Using bandpass filters in CATV systems

Figure 1



By Elizabeth Beltowski
Media Specialist, Microwave Filter Co.

A bandpass filter passes a selected spectrum (a TV channel, for example) with acceptable through-loss and suppresses all frequencies above and below this spectrum. Channel-selective bandpass filters are illustrated here. These are very sharp filters that suppress the closest carriers of adjacent channels lower sound, upper video and beyond. Figure 1 illustrates some CATV system applications of channel-selective bandpass filters.

CATV antennas are usually wide-band; they can receive a number of channels. For example, many broadband VHF antennas can efficiently receive Chs. 2-6, while others can receive Chs. 7-13, etc. Usually, however, the antenna is pointed at only one desired TV transmitter. If this is a distant channel, we will often pick up a strong, unwanted adjacent channel. If the unwanted channel is sufficiently strong, it may overload the preamp and degrade the reception of the desired channel. In this case, a channel-selective filter can be inserted in the line between the antenna and preamp. The filter passes the desired channel and suppresses the adjacent channel. Where there is no preamp, the filter is placed just before the channel processor.

Another frequent application is the cleaning up of the processor output before combining the channel with others at the common headend combiner. This is necessary if the processor puts out other frequencies outside the intended channel. Unless these spurious outputs are suppressed greater than 60 dB, they will degrade other channels. Figure 2 illustrates the action of a channel-selective bandpass filter in cleaning up "band-

Figure 2

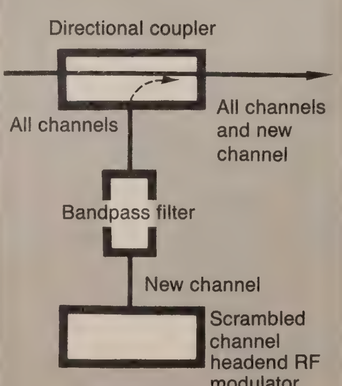


Figure 3

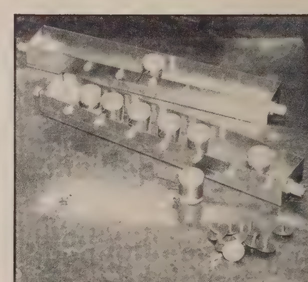


Figure 4

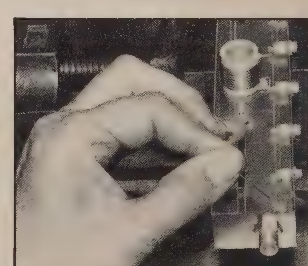
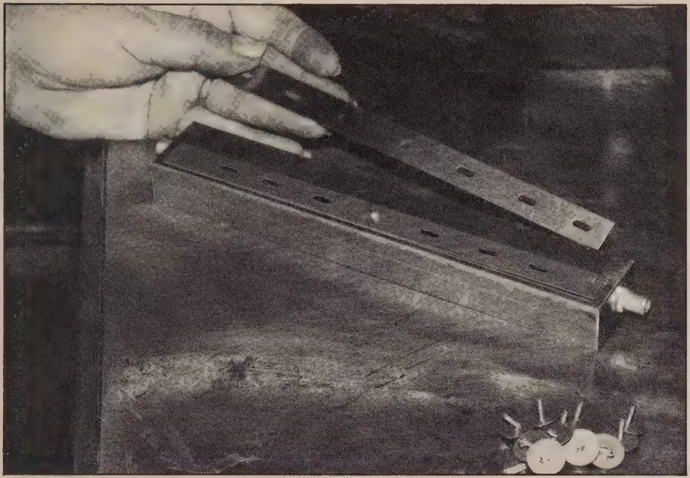


Figure 5



"A bandpass filter is simply a string of resonators that are tuned to the channel center frequency."

spreading" of an RF modulator before connection to the headend combiner.

Bandpass filter structure

A bandpass filter is simply a "string" of resonators that are tuned to the channel center frequency. Depending on the specific operator frequency, the resonators are lumped constant (coils and capacitors), helical (sections of spiral transmission line tuned with capacitors) or coaxial cavities consisting of a rod (center conductor) and tube (outer shell).

The resonators of a channel-selective bandpass filter are tuned to the channel center frequency. The amount of coupling between resonators determines the bandwidth (the frequency span with low through-loss). Finally, the input and output connectors are coupled to the first and last resonators. The coupling capacitance value is determined by the line impedance that the filter must work into. For CATV applications, this impedance is 75 ohms.

Figures 3 through 8 illustrate the steps in manufacturing a channel-selective bandpass filter. This one uses helical resonators with very high circuit Q, resulting in lower channel through-loss than would lumped constant resonators. In Figure 3, helical resonators are wound

(continued on page 49)

Figure 6

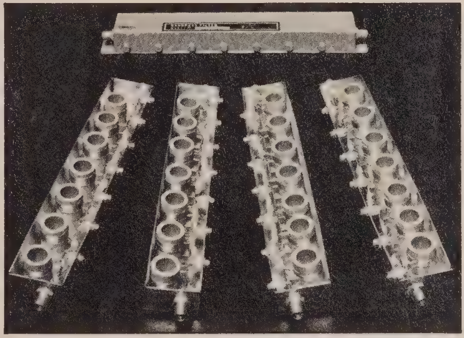
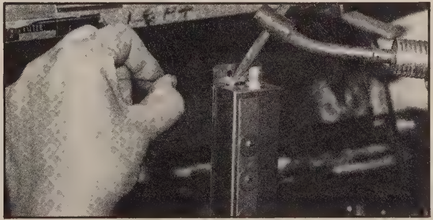


Figure 7



Trunk and feeder cables

Now available from Times Fiber Communications is its CATVX-rated drop cable. Approved by Underwriters Laboratories, the new CATVX products meet the required 1987 National Electrical Code, Article 820, "Community Antenna Television and Radio Distribution Systems." Calling it the future dimension in trunk and feeder cable the new T6 is the only cable specified to consistently sweep to 600 MHz, according to Times Fiber.

Consistent with the standard specification of T4+, T6 features the exclusive bonding and full wall seamless construction, which provides increased protection against the elements.

For more details, contact Times Fiber Communications, 358 Hall Ave., P.O. Box 384, Wallingford, Conn. 06492, (203) 265-8500; or circle #131 on the reader service card.

Crimp tools

Cable Management Systems introduced two new crimp tools for use with its RJ line of modular connectors. The Model FIT 26 is capable of stripping and terminating two-, three-, four- and six-position line cords using 26 and 24 AWG solid or stranded wire. The FIT 28 is designed for eight-position line cords. Both tools are metal, with plastic insulation-covered handles and blades for cutting and stripping modular line cord.

For more details, contact Cable Management Systems, 17955 Skypark Circle, Suite F, Irvine, Calif. 92714, (714) 261-2622; or circle #134 on the reader service card.

Headend product

Scientific-Atlanta introduced the frequency agile drawer. It can be installed in an S-A 6350 modulator or 6150 processor. It can also back up an entire headend as a replacement module and has a 550 MHz range for compatibility with every cable system, according to the company.

For more information, contact Scientific-Atlanta, 1 Technology Pkwy., Box 105600, Atlanta, Ga. 30348, (404) 441-4000; or circle #130 on the reader service card.

Cable connectors

Cable Connector Corp. is offering its VSF line of coaxial aluminum cable connectors for standard .412, .500 and .750 cables. The line has been expanded to accommodate .625 cable and popular sizes of Comm/Scope's Quantum Reach and Trilogy's MC2.

The line includes feed-thru, pin-type, splice, cable-to-F, 90-degree and housing-

to-housing connectors, which use an integral shield to minimize signal egress. The connectors feature firm clamping mechanisms to reduce suck-out and plating and O-rings to minimize corrosion and prohibit moisture leaks, according to the company.

For further details, contact Cable Connector Corp., P.O. Box 87, Atkinson, N.H. 03811-0087, (617) 374-0553; or circle #135 on the reader service card.

Agile upconverter

Hughes Aircraft Co.'s Microwave Products Division introduced a frequency agile upconverter for use with its AML-MTX-132 transmitter. The Model AML-AUPC-135 can be used as backup for any one of the 80 TV channels of the MTX-132, and also as a ninth channel in a bay able to carry a non-premium channel, then switched to carry a premium channel if necessary.

According to Hughes, it can quickly be switched over to the agile upconverter during maintenance or retuning from an existing channel module. It has a bandwidth of 550 MHz, requires no tuning and operates in the CARS (12.7 to 13.25 GHz) band.

For additional details, contact Hughes Aircraft Co., Microwave Products Division, P.O. Box 2940, Torrance, Calif. 90509, (213) 568-6307; or circle #128 on the reader service card.

Fiber-optic cable

Available from General Instrument's Comm/Scope Division, the Optical Reach single-mode loose buffered construction fiber-optic cable comes in configurations of two to 72 optical fibers.

The company is presenting this cable as part of a package involving fiber-optic cable, assistance in implementing it in an existing or new system, electronics and hardware.

For further details, contact Comm/Scope Division, General Instrument, P.O. Box 1729, Hickory, N.C. 28602, (800) 982-1708; or circle #133 on the reader service card.

Addressable converter

Pioneer Communications of America introduced its BA-6000 addressable converter with the optional VCR filter. This option combines the output of the converter with the cable input, restoring the tuner functions of the VCR and television and permitting the subscriber to record and watch different channels. It also allows the timer on the VCR to be utilized fully-independent of the four additional timers on the converter.

Other features include volume control, enhanced display, larger remote, integrated IPPV modules, downline-loadable output channel and multi-vendor compatibility.

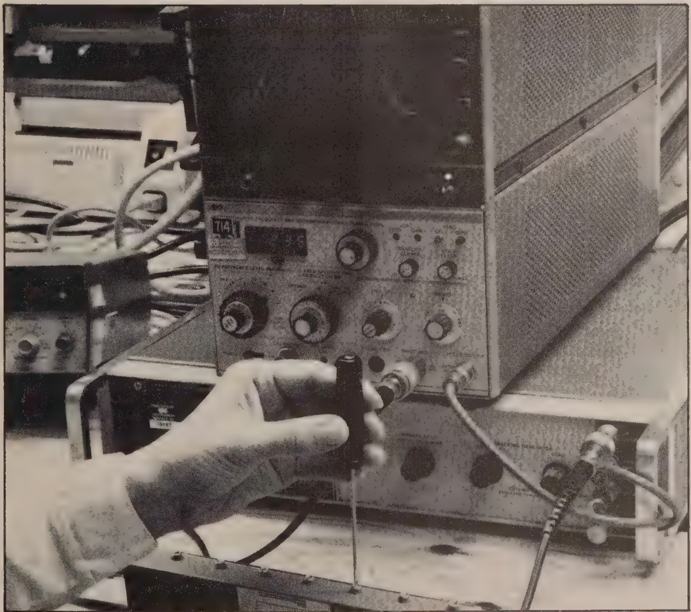
For further information, contact Pioneer, Sherbrooke Office Centre, 600 E. Crescent Ave., Upper Saddle River, N.J. 07458-1827, (201) 327-6400; or circle #134 on the reader service card.

Satellite locator

The Satellite Locator from WTS Products is a slide rule that gives azimuth/elevation angles to geosynchronous satellites from almost anywhere on Earth. This device allows the quick determination of az/el angles from anywhere on Earth that the satellite arc is visible. A magnetic declination map and a true/magnetic slide rule on the back allows the true azimuth to be converted to local magnetic azimuth. The az/el formulas also are printed on the back.

For more details, contact WTS Products, 4308 S. Peoria, Suite 681, Tulsa, Okla. 74105; or circle #132 on the reader service card.

Figure 8



(continued from page 47)

on grooved coil forms made of very low loss dielectrics, such as Teflon or polystyrene. The resonators are inserted in the housing of a seven-resonator filter (Figure 4). Special provisions must be made to obtain a positive RF ground for each resonator. Note that each resonator is tuned by its own high Q adjustable capacitor.

Figure 5 shows a resonator spacing strap being installed. The screw hole pattern in the strap will force the internal resonators to assume the proper approximate spacing for correct magnetic coupling to neighboring resonators. Exact position will be adjusted during tuning.

In Figure 6, the assembled bandpass filters are ready for covering. Figure 7 shows the case cover being soldered in place to preserve the high Q of the resonators by providing a low resistance path to circulating currents. Finally, in Figure 8, the filter is tuned using a swept spectrum analyzer. The tuning capacitors are adjusted to center the filter on the channel center frequency. Then they are fine-tuned to achieve a flat passband. Outside accessibility of the tuning screws facilitates field retuning if this should become necessary. ■

Solving microwave problems

By Tom Hill
Assistant Director of Engineering
Sammons Communications

The ideas I'm going to share with you are just some simple techniques that are applicable not only for troubleshooting problems with microwave systems but for isolating problems in other CATV equipment. In order to quickly and effectively troubleshoot any device or system, it requires a basic understanding of what you're troubleshooting and an established, orderly approach. It may not be necessary to know the exact function of each and every component in a microwave transmitter or receiver, but you should have at least a module-by-module understanding of what you're doing.

A comparative example would be of first learning how to drive a car. You soon learn that by pulling certain knobs and pushing certain pedals in a prescribed fashion, the car will start, go forward or slow down and hopefully stop. It is not absolutely necessary that you know exactly what happens in the engine when you press the accelerator or what takes place when the brakes are applied. Knowing just a certain amount is fine when everything is working properly, but what happens someday when you press the gas pedal as usual and nothing happens? That's when a broad understanding of automobiles and engines becomes important. If you understand the workings of carburetors, fuel pumps, ignition systems and the like, then you can possibly determine what may be wrong with the car.

The same principle holds true when troubleshooting a microwave problem or a malfunction with just about any other device, whether it be mechanical or electrical. You may know from experience that turning a certain adjustment will give you a certain meter reading. But what happens when you turn that control one day and nothing works? What do you do then? That's when it is helpful to understand what that control does in relation to that meter. Of course, the quickest and best approach might be to swap out the module(s) containing that control and meter. That's when a "block diagram familiarity" with that piece of equipment would be helpful. If you understand how the RF flows through the block diagram and what voltages are required by each module, you can quickly monitor the "vital signs" of any device.

What is normal?

In very simple terms, if you have a "good" signal in one place and a "bad" signal in another place, your job is to find out where the transition from good to bad occurs. Other than looking at pictures or perhaps measuring various signal levels, how do you know that a certain DC voltage or signal level is not normal unless you know what *is* normal? A suggestion is to either commit to memory or, better yet, record each meter reading on every transmitter and receiver. Also measure and record signal levels at certain key locations, especially out of the transmitter, the waveguide feeding the transmit antenna, the receive antenna feedhorn and the waveguide feeding the receiver.

You also could take Polaroid pictures of spectrum analyzer displays that will show either all channels or individual channels. Then you will have visual evidence of levels, picture-to-sound carrier ratios, the absence of any beats and the average noise level normally present. These will provide the vital signs during the normal operating conditions of each transmitter and receiver, just like a doctor checking your body temperature, blood pressure, pulse rate and blood samples. Take it upon yourself to know and record the vital signs of your equipment when everything is working perfectly, so that when it isn't, you are prepared. Also, this recorded information will help someone else if you are not available when the outage occurs.

By the way, when you record these levels and/or take your spectrum analyzer pictures, record specifically where you took the readings, what kind of adaptor (WR75 to N, for example) was used and the significant settings on each piece of test equipment. That way you can duplicate the setup exactly as it was originally done.

All of the vital signs and information should be recorded in a log book that should be kept at each transmitter and receiver site. The log book should have serially numbered, non-removable pages to develop a measurement history of each site. You should regularly log AGC readings, frequencies, power levels, video levels, air pressure, battery charger current and voltage. In fact, record everything that will affect the operation of the transmitter or receiver. If you come in and some reading is not normal, log that reading. Then do whatever is necessary to achieve a normal reading and log whatever it was you did. If you only record normal readings, you or others may not realize that the frequency is always drifting, for example, due to inadequate air conditioning or whatever.

I know of one headend where the AGC voltage of the FM receiver was logged each month, and over a six- to nine-month period, it slowly dropped a few tenths of a volt each month. Month to month the change was very small, but over the long period of time it had dropped a few volts. Upon investigation, we discovered moisture in the elliptical waveguide between the tower and the building. After the waveguide was dried out, the AGC level went back up to where it had been months ago. Of course, pictures and the fade margin improved too. The lesson to learn from this is record everything since problems are so subtle and can sneak up on you.

One troubleshooting approach is called "half splitting." Let's say you have a string of 20 series-type Christmas tree lights, but none of them will work. You are pretty sure there is a bad bulb, but which one? You could start on one end with an ohmmeter and check the bulbs one by one until you find the bad one. But suppose the 20th bulb is faulty? The faster approach would be to check the resistance (continuity) from the AC plug to the 10th plug. If it's good, then the problem is between bulbs 10 and 20. Then by checking the 15th bulb and so on, in about five steps you could find the bad bulb. Troubleshooting microwave is more complex than finding a bad bulb, but the half-splitting technique is still valid.

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Preventive maintenance

A well-organized troubleshooting program begins long before anything ever needs repair. The preventive maintenance you and others have been doing since the day the equipment was first put into service will have a tremendous bearing on how long and how often you are out on trouble calls.

It starts with making sure the tower and incoming waveguide are properly grounded. Is there a source of standby power? Is the AC to the power supplies adequately protected from power surges and sags? And up on the tower, are the dishes properly braced with the additional fixed side strut? Is the waveguide carefully secured at the recommended intervals or better? One weak link is the elliptical waveguide feeding the dish. Always ask yourself, "Would all of this stay secure and solid with a substantial layer of ice on it and with a strong, gusty wind blowing?" If you are not sure, then make sure. Many outages often coincide with a storm, high winds and associated lightning. In fact, knowing the exact weather conditions within each path can often help you to determine if the problem is weather related or not.

Also, don't neglect the effects of even a very still morning as the air begins to warm up, as well as a quiet cool down in the evening. You can get some tremendous temperature inversion fades during these conditions. Unfortunately, there is not much you can do about them except to be sure you still have every bit of fade margin that was originally designed into each path.

Just what is fade margin? One definition is: the amount of received signal level reduction that can be tolerated before arriving at a certain minimum desired level into the receiver. Most microwave paths are designed to give you a receive level of around −40 dBm, which will produce excellent pictures. If the level drops to around 60 dBm, the pictures may become very noisy and the television may even lose sync. If there is moisture in the waveguide or if the dishes aren't aligned properly (or a number of other possibilities), your receiver level may drop to, let's say, around −50 dBm. This means that it will take very little rain or inversion fades before your pictures become very bad to the point of being unwatchable.

Fade margin loss

The loss of fade margin can sneak up on you in many ways. There was a microwave path in Illinois that during winter a few years ago started getting very noisy pictures at night. The first assumption (which proved to be incorrect) was that one of the dishes may have moved during a storm, which would have reduced the receive level and its fade margin. The temperature was below freezing even during the day and although the sun shone some, we really couldn't see how the problem could be temperature related.

During the day, when the pictures were good, a technician climbed the tower. As we closely watched the AGC meter, he removed the air plug on the waveguide connector at the dish. When he released the air pressure, the AGC meter started jumping all over the place. From that we concluded that although the outside air temperature was staying below freezing, there must be liquid in the waveguide that was moving and bubbling as the air flowed over and through it, causing the input level (and AGC voltage) to fluctuate. The black vinyl jacket on the elliptical waveguide was absorbing enough heat to keep the moisture liquid during the day. Then, at night, ice formed in the waveguide, which severely attenuated the receiver input level and thus brought about the nighttime snowy pictures. Here was a case where even though there was moisture in the waveguide, the pictures were good until it froze. So we had been operating with a reduced fade margin.

Troubleshooting microwave problems sometimes requires a lot of detective work in order to quickly get to the root of the problem. For instance, if you have a "no signal" situation, did the outage coincide with any of the following:

- a storm, especially one with very high winds, heavy rains and lightning?
- anyone doing work at the headend site that may have inadvertently affected the microwave?
- any power interruptions, glitches, brownouts or outages?

If you have a "weak signal" condition, check to see if it is something that happened suddenly or if it has been getting progressively worse over days or weeks. Weak signal problems could be caused by rain, wind, temperature inversions, a weak klystron, an electronics failure and last, but surely not least, the input to the microwave itself could be at fault.

Above all, on that day (or night) when someone excitedly tells you "the microwave is down, so fix it," don't panic. Be cautious about making any absolute assumptions or drawing any quick conclusions. Keep an open mind while considering just what the problem is. ■

F connector installation at a drop

Recent CATV industry research indicates that most service-related truck rolls are due to problems at the drop. In particular, improper F connector installation is contributing to unacceptable signal leakage levels, poor picture quality and repeated service calls. Therefore, it appears essential to review proper installation procedures to try to reduce this costly problem. The following is an excerpt from NCTI's newly revised aerial installation lesson.

Placing F connectors on CATV coaxial cables is one of the most important skills and most frequently repeated procedures that will confront the installer. F connectors are somewhat standard, but vary enough in mechanical structure so that an exact description of cable preparation is difficult. It is important, however, to use the correct F connector for the size of coaxial cable being installed: F56 for RG6/U and F59 for RG59/U.

The following is a recommended procedure:

1) Strip cable to expose three-eighths to one-half inch of the center conductor. Do not score the center conductor. Clean off all dielectric that is on the center conductor (Figure 1).

2) Remove one-eighth to three-sixteenth inch of the outer jacket. The outer foil on double-foil cable also must be removed to expose the braid (Figure 2).

3) Fold the braid over the outer jacket. Twist the foil tight in the direction of overlap (Figure 3).

4) When using a fitting with a separate crimp ring, push the crimp ring over the braid but not past the braid (Figure 4A). Twist the fitting on with the inner sleeve over the foil and under the braid (Figure 4B). The center dielectric must be flush with the inside center of the F connector (Figure 4C).

5) When using a one-piece fitting and crimp ring, twist the fitting on in the direction of the foil wrap, with the inner sleeve over the foil and under the braid (Figure 5). The center dielectric must be flush with the inside center of the F connector. The outer sheath or conductor, whether braid or foil, must *not* be pushed back or broken under the outer jacket. Also, the sheath should not protrude below the base of the F connector.

6) The crimp ring, whether long shank, small, individual or integral, must be crimped over the outer jacket after the outer sheath or braid is correctly prepared under the jacket. Crimp the ring with the proper crimping tool and hex cavity size (Figure 6).

7) Trim the center conductor one-sixteenth inch beyond the end of the F connector (Figure 7). ■

"Placing F connectors on CATV coaxial cables is one of the most important skills... that will confront the installer."

Figure 1: Center conductor exposure and cleaning

Figure 2: Outer jacket removal

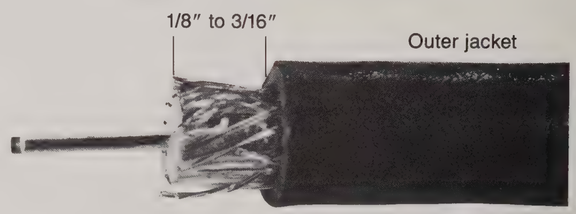


Figure 3: Braid folded over outer jacket

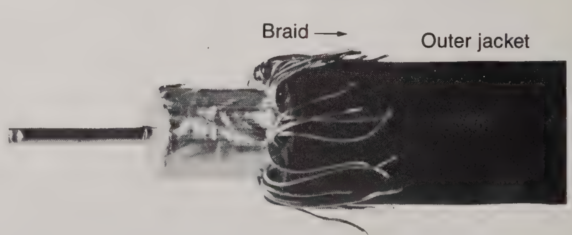


Figure 4A

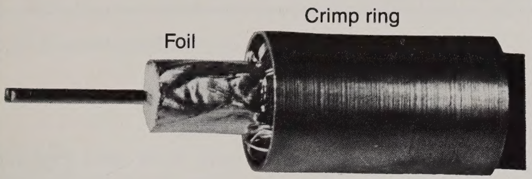


Figure 4B

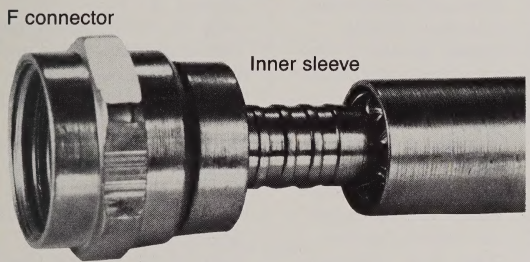


Figure 4C

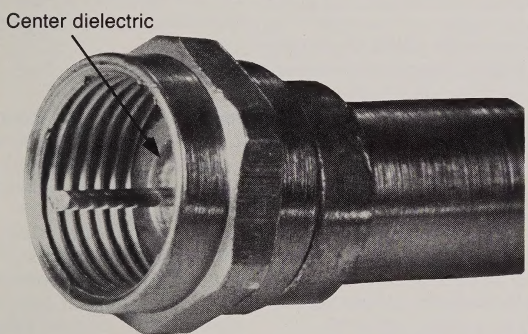


Figure 5: One-piece fitting and crimp ring installation

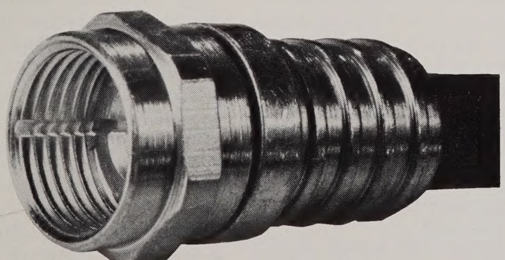


Figure 6: Crimping tool and crimped crimp rings

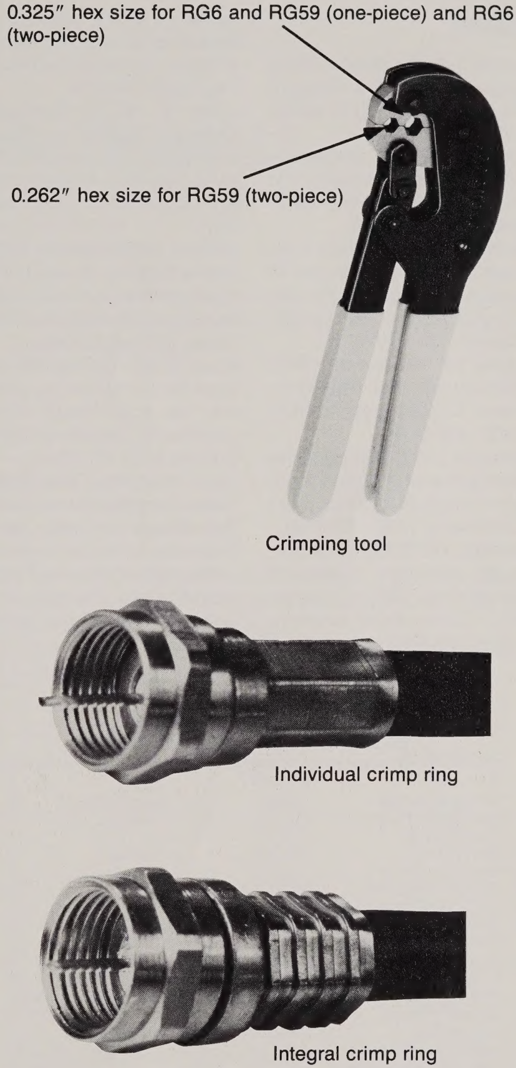
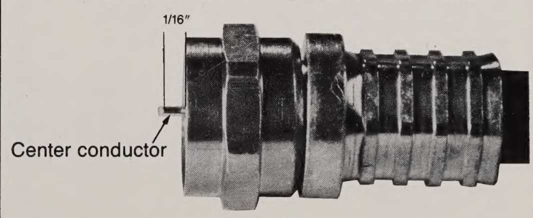


Figure 7: Center conductor trimming



Calendar

June

June 1-3: Magnavox CATV training seminar, Casper, Wyo. Contact Amy Costello, (800) 448-5171.
June 3: SCTE Palmetto Meeting Group technical seminar. Contact Rick Barnett, (803) 747-1403.
June 6-9: Siecor Corp. technical seminar on fiber-optic installation and splicing for utility applications, Hickory, N.C. Contact (704) 327-5539.
June 7-9: Magnavox CATV training seminar, San Francisco. Contact Amy Costello, (800) 448-5171.
June 8: SCTE Central Oklahoma Meeting Group technical seminar. Contact Gary Beikmann, (405) 842-2405.
June 8: SCTE Rocky Mountain Chapter technical seminar on signal processing. Contact Steve Johnson, (303) 799-1200.
June 8: SCTE Wyoming Meeting Group technical seminar. Contact Drew Fleming, (307) 745-7333.
June 9: SCTE Greater Chicago Chapter technical seminar on construction and cable handling. Contact William Gutknecht, (312) 690-3500.
June 9: SCTE Central California Meeting Group technical seminar on proof-of-performance. Contact Andrew Valles, (209) 453-7791.
June 13-15: Hughes Microwave technical training seminar on broadband AML equipment, Torrance, Calif. Contact (213) 517-6244.
June 13-15: New York State Cable Commission on Cable Television's Northeast Cable Television technical seminar on fiber optics, Roaring Brook Ranch, Lake George, N.Y. Contact Bob Levy, (518) 474-1324.
June 15: SCTE Midlands Cable Training Association seminar on transportation systems, Omaha, Neb. Contact Herb Dougall, (402) 330-2314.
June 16-19: SCTE Cable-Tec Expo, Hilton Hotel, San Francisco. Contact (215) 363-6888.
June 21-23: C-COR Electronics technical seminar, Minneapolis. Contact Shelley Parker, (800) 233-2267.
June 24: SCTE Heart of America Chapter technical seminar. Contact Wendell Woody, (816) 474-4289.
June 28: SCTE Hudson Valley Chapter technical seminar on CLI, Holiday Inn, Kingston, N.Y. Contact Wayne Davis, (518) 587-7993; or Bob Price, (518) 382-8000.
June 29: SCTE Delaware Valley Chapter technical seminar on CLI, leakage and FCC rule update, Williamson Restaurant, Horsham, Pa. Contact Diana Riley, (717) 764-1436.
June 29: SCTE Rocky Mountain Chapter technical seminar, Breckenridge, Colo. Contact Steve Johnson, (303) 799-1200.

Upcoming

June 16-19: Cable-Tec Expo, Hilton Hotel, San Francisco.
July 11-14: New England Show, Tara Hyannis, Cape Cod, Mass.
Sept. 7-9: Eastern Show, Atlanta Merchandise Mart, Atlanta.
Sept. 27-29: Great Lakes Expo, Cobo Hall, Detroit.
Oct. 4-6: Atlantic Show, Convention Center, Atlantic City, N.J.
Oct. 18-20: Mid-America Show, Hyatt Regency, Kansas City, Mo.
Dec. 7-9: Western Show, Convention Center, Anaheim, Calif.

July

July 11-14: New England Cable Television Association's annual conference and expo, Tara Hyannis, Cape Cod, Mass. Contact William Durand, (617) 843-3418.
July 14: SCTE Central California Meeting Group technical seminar on fiber-optics technology. Contact Andrew Valles, (209) 453-7791.
July 25: SCTE Golden Gate Chapter technical seminar on safety programs. Contact Wayne Sheldon Sr., (408) 264-2728.
July 25-28: Siecor Corp. technical seminar on fiber-optic installation and splicing for local area networks and campus applications, Hickory, N.C. Contact (704) 327-5539.

August

Aug. 3: SCTE Rocky Mountain Chapter technical seminar on distribution systems. Contact Steve Johnson, (303) 799-1200.
Aug. 8-11: Siecor Corp. technical seminar on fiber-optic installation and splicing for utility applications, Hickory, N.C. Contact (704) 327-5539.
Aug. 8-12: Hughes Microwave technical training seminar on channelized AML equipment, Torrance, Calif. Contact (213) 517-6244.
Aug. 10: SCTE Oklahoma Meeting Group technical seminar. Contact Herman Holland, (405) 353-2250.
Aug. 11: SCTE Central California Meeting Group technical seminar on troubleshooting power problems. Contact Andrew Valles, (209) 453-7791.
Aug. 24: SCTE Appalachian Mid-Atlantic Chapter technical seminar. Contact Ron Mountain, (717) 684-2878.

Ad Index

Decibels (Part 1)

By Ron Hranac
Jones Intercable Inc.

The decibel (dB) is the basis for much of the mathematics of cable television. By itself, the decibel is a relative term used to express power ratios and is based upon logarithms. The number of decibels corresponding to a particular power ratio is calculated with the formula

$$dB = 10\log_{10}\left(\frac{P_2}{P_1}\right)$$

where:
P_1 = input power
P_2 = output power

From this formula, it can be found that doubling a given power level is a 3 dB change; reducing a power level by half also is a 3 dB change. Increasing or decreasing a power level 10 times is a 10 dB change, and increasing or decreasing a power level 100,000 times is a 50 dB change.

The following chart provides a useful reference of common power ratios and their relationship in decibels. Examples of the use of the above formula are on the next page.

Power ratio	Change in decibels	Power ratio	Change in decibels	Power ratio	Change in decibels
1	0	30	14.77	5,000	36.99
2	3.01	40	16.02	6,000	37.78
3	4.77	50	16.99	7,000	38.45
4	6.02	60	17.78	8,000	39.03
5	6.99	70	18.45	9,000	39.54
6	7.78	80	19.03	10,000	40
7	8.45	90	19.54	11,000	40.41
8	9.03	100	20	12,000	40.79
9	9.54	200	23.01	13,000	41.14
10	10	300	24.77	14,000	41.46
11	10.41	400	26.02	15,000	41.76
12	10.79	500	26.99	16,000	42.04
13	11.14	600	27.78	17,000	42.30
14	11.46	700	28.45	18,000	42.55
15	11.76	800	29.03	19,000	42.79
16	12.04	900	29.54	20,000	43.01
17	12.30	1,000	30	50,000	46.99
18	12.55	2,000	33.01	100,000	50
19	12.79	3,000	34.77	1,000,000	60
20	13.01	4,000	36.02	10,000,000	70

Problem

You have a 50-watt stereo at home, and your neighbor has a 100-watt stereo. What is the difference between the two power outputs in dB?

Solution

$$dB = 10\log_{10}\left(\frac{P_2}{P_1}\right) = 10\log_{10}\left(\frac{100}{50}\right) = 10\log_{10}(2) = 10(0.30103) = 3.01\ dB$$

Problem

An off-air antenna array at the headend has 20 dB of gain. How much of a power increase will that antenna array provide to off-air signals?

Solution

Referring to the chart on the previous page, find 20 dB in the "change in decibels" column. The number next to it in the "power ratio" column is 100. The antenna array increases the power of the received off-air signals 100 times.

Problem

A local broadcast station is transmitting with 500 watts of power, and another with 1,000 watts. What is the difference between the two power levels in dB?

Solution

$$dB = 10\log_{10}\left(\frac{P_2}{P_1}\right) = 10\log_{10}\left(\frac{1{,}000}{500}\right) = 10\log_{10}(2) = 10(0.30103) = 3.01\ dB$$

Problem

Your cable system uses handheld two-way radios, each with 5 watts RF output. The base radio at the office is 35 watts. What is the difference between the base radio and a handheld radio output in dB?

Solution

$$dB = 10\log_{10}\left(\frac{P_2}{P_1}\right) = 10\log_{10}\left(\frac{35}{5}\right) = 10\log_{10}(7) = 10(0.8451) = 8.45\ dB$$
